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BLERIOT'S NO. 11 MONOPLANE WITH WHICH HE FLEW ACROSS THE ENGLISH CHANNEL.

THE NEW R. E. P. MONOPLANE, WHICH HAS THE MOST NOVEL FEATURES OF ANY MACHINE OF THIS TYPE.

SOME EXHIBITS AT THE SECOND PARIS AERONAUTICAL SALON.—[See page 280.]

IRON AND STEEL.*

THEIR RELATION TO OTHER INDUSTRIES.

BY F. W. HARBORD.

Concluded from Supplement No. 1764, page 259.

The modern type of mixer is usually gas-fired, the air, if not the gas, being regenerated, and is similar in general construction to a large tilting open-hearth furnace, and it is becoming more and more the general practice to use this as a preliminary refining furnace by the addition of suitable fluxes. Many of these mixers are now basic lined, and, by the formation of suitable slags, not only can the metal be desiliconized but largely desulphurized, matters of the greatest importance if the metal is afterward to be treated by the basic process either in the converter or the open-hearth furnaces. For many years various attempts were made to use molten iron from the blast furnace or cupola in the open-hearth acid and basic furnaces, but without success, owing chiefly to the excessive wear and tear on the bottom. This was due largely to the irregular composition of the metal, and also to the method employed in the early days of making the hearths of basic furnaces, which were either rammed or bricked. Now the basic material is glazed on layer by layer, with the result that the very hard bottom, all fritted together, is well able to resist the cutting action of the molten metal. So far as the acid open-hearth process is concerned, there is probably little advantage in using molten metal, as it is not possible to add oxides of iron on the silica hearth of the furnace to effect rapid oxidation of the impurities, and it has not been generally adopted. In the basic open-hearth, provided a partially refined metal of regular composition from a mixer can be obtained, very rapid oxidation of impurities can be effected by oxidizing slags, and considerable saving in time in the working of the charge is effected. Comparatively few early basic open-hearth plants had blast furnaces attached from which molten metal could be obtained, or probably its use would be more common to-day. Where there were blast furnaces there were no facilties for charging the open-hearth furnaces with the molten metal, and to provide these would have necessitated in many cases the practical rebuilding of the melting shop, as the building would not have been strong enough to carry overhead cranes, or the open-hearth platform, to carry the ladle full of molten metal.

In modern Bessemer works, whether acid or basic, the practice is to take the metal from blast furnaces to a mixer and thence to the converter. The mixer is not expensive to work, as it requires little attention and the repairs are few.

In the open-hearth acid plants, when cold materials are charged, the increase in the size of the furnaces has necessitated mechanical charging, and this has been met by the Wellman charger and similar machines by which the materials are charged about a ton at a time from boxes. This has reduced the hard manual labor, and effected a great saving in the time of charging, thus considerably increasing the output and decreasing the fuel consumption.

In basic open-hearth works the best practice is to take molten metal, previously subjected to a preliminary refining in a mixer, direct to the open-hearth furnace, some of the ore and lime having been previously charged into the furnace by a Wellman charger, but in works where molten metal is not available cold materials must be charged as in the acid process. Attempts have been made many times to use an acid Bessemer converter in combination with basic open-hearth furnaces, and in some works the results appear to be satisfactory. The molten metal, either direct from the blast furnace or after passing through a mixer, is desiliconized and partially decarburized and then transferred to a basic open-hearth furnace to be converted into finished steel. Provided the Bessemerizing is stopped before any large percentage of the carbon has been removed, and that the metal is comparatively low in phosphorus, so that when the metal is transferred to the open-hearth furnace the proportion of carbon to phosphorus is relatively high, good results may be obtained, but in the case of high phosphoric metal the removal of carbon to any appreciable extent before transferring the metal to the open-hearth would, one anticipates, greatly increase the difficulty of obtaining regularly low phosphoric steel, as there would be considerable risk of the carbon being oxidized before the phosphorus. Within the last few years several important modifications of the basic open-hearth process have been introduced, but the only two of any practical importance are the Bertrand-Thiel and the Talbot continuous process. In the Bertrand-Thiel, either cold metal or molten metal from a mixer is largely dephosphorized and partially decarburized in what is known as a primary furnace, and when the carbon is reduced to about 1.5 to 2.0 per cent and the phosphorus to about 0.2 per cent, it is transferred to a finishing furnace, in which scrap, oxide, and some lime have been previously heated, care being taken to prevent any of the phosphoric slag formed in the primary furnace passing into the finished furnace. This process was at work for some time on the Continent and in America, and later in this country at the Round Oak and Brymbo Steel Works, and no doubt excellent steel of very regular quality can be produced, but it has not so far been adopted at other works. One difficulty in adapting this process to an ordinary open-hearth plant is the transferring of the metal, as unless furnaces can be arranged one below the other, the molten metal would have to be raised to be poured into the finishing furnace, which in many cases might be difficult unless the plant were specially designed with a suitable overhead crane.

The Talbot continuous process involves the use of large tilting furnaces, and molten metal from a mixer is charged and converted into steel in the usual way. Instead, however, of pouring the whole charge, only a portion equal to about one-third of the contents of the furnace is teemed, and then a ladle of mixer metal equal in weight to that removed is poured into the bath of finished steel remaining in the furnace. Oxides and lime additions are made in the usual way with a Wellman charger, and when the metal is dephosphorized and decarburized to the required extent, another third is cast into ingots and more mixer metal charged into the furnace. In this way the furnace is worked continuously, being, even after the pouring of a charge of finished steel, always two-thirds full of molten steel, and it is only emptied at the week end. There are a number of furnaces at work or building in England, on the Continent, and in America, and Mr. Talbot informs me that these furnaces when in full work will be capable of producing over 1,000,000 tons per year. There is no doubt that the quality of the steel is excellent, and the large outputs obtainable and small labor charges make it a very serious competitor with the ordinary open-hearth. The tendency seems to be to make the furnaces larger and larger, and a 250-ton furnace is now being erected in the North of England. These large furnaces, with necessary foundations and varied appliances for dealing with such large quantities of material, are necessarily very costly, and this is probably the principal reason why they have not been more generally adopted, as frequently it necessitates the entire reconstruction of the open-hearth shop.

In Bessemer practice the addition of oxides of iron in the basic converter by increasing the fluidity of the slag and decreasing the waste, although only a detail, is of some importance, and was first used in this country some years ago, although quite recently it has been described as a new modification in the technical press. The more general use of mixer metal has considerably increased the yield, and also reduced the cost of repairs, but in other respects both acid and basic Bessemer processes are carried on as they were twenty years ago.

With the increased size of converters and furnaces, mechanical means have been devised for handling the large quantities of metal, and overhead cranes to carry ladles which hold 50 tons of metal are now common in large works. To deal with this large quantity of metal before setting has necessitated the casting of large ingots and all the mechanical appliances for dealing with these. Instead of 18 hundredweight to 25 hundredweight ingots, as was customary some years ago, 2 to 5 tons, and frequently larger ingots are now regularly cast, and the ingot molds, instead of being placed in sunk pits, are frequently carried on cars on the floor level of the shop, and directly the entire heat is teemed, are drawn away by a locomotive to the stripper, where the ingot molds are removed, and the ingots immediately taken away to the soaking pits or gas-fired reheating furnaces. This increase in the size of ingots has necessitated again larger reheating furnaces, and especially larger and more powerful rolling mills for cogging down and finishing, and more powerful engines for driving the mills. With the assistance of our engineers all these requirements have been met, and to-day rails 180 feet long are rolled in some of our large rail mills, and plates over 12 feet wide in our plate mills. Not only, however, has progress been marked by an increase in size, but at every point mechanical devices have been introduced to save labor, increase the speed of working, and to reduce the cost of manufacture.

Previous to 1870 all rails were rolled in pull-over mills, and the maximum output was 100 per shift and rarely exceeded 50 tons. To-day a reversing rail mill with cogging, roughing, and finishing mill will turn out 350 tons per shift, and one works in England has rolled 4,000 tons in a week, and another works, not in this country, but with which I am acquainted, has turned out 6,000 tons. But it is not only in the special mechanical appliances connected with our industry that we have to thank our engineering friends, but also for providing us with engines capable of running at almost any speed, for our small mills, and reversing engines capable of withstanding the great and sudden stresses to which they are subjected, which are under absolute control, are steady in running, and easily handled and rapidly reversed.

To the engineers, also, we owe the great economies in fuel which have resulted from the use of high pressure steam—expansion, condensing, and compounding—economies which have been of the greatest importance to our industry in view of the large amount of power used in our works. As, however, the steam engine has displaced the water wheel, so now in its turn it appears to be in danger of being ousted by the dynamo and electric motor. We have already seen that it is no longer a question of steam engine versus gas engine for blowing our blast furnaces, but the contest is between the gas engine and the steam engine combined with the turbine; and now we have electric driving for mills claiming the most serious attention of all practical steel works men. For many years we have been using electric motors for driving our cranes and for a number of subsidiary purposes, and now electrically driven mills are an accomplished fact. Both reversing and continuous mills are being electrically driven, and I believe I am correct in saying that in this district Sir Alfred Hickman has just completed the equipment for driving his rolling mills electrically. Now that the initial difficulties in the design of the electrical plant necessary to meet the special conditions have been overcome, there seems every probability that electrical driving will gradually but surely replace steam driving.

Again, if we consider the forging of large masses of steel which are necessary to meet the modern requirements of our latest battleships, we have to thank our engineers for the modern forging press, which has so largely replaced the steam hammer for the forging of our large guns and armor plates. Presses are now in use capable of giving pressure from 14,000 to 20,000 tons, and the work done by these is so much better than the hammer that the latter is gradually being superseded for heavy high class work, and even for small work the modern rapid forging press is gradually being adopted.

While, however, the engineer has, by his designs of improved machinery, made modern progress in iron and steel possible, it has only been so by the metallurgist supplying him with a material suitable for his machines at a cost undreamt of a few years ago. Each year he is demanding a material of greater strength combined with greater ductility and making his specifications more rigid as regards the purity of the materials he uses and the mechanical tests it has to withstand. Thus, in railway materials we have to supply rails capable of resisting greater crushing load and resistance to wear, due to the greater weight of rolling stock and higher speed, axles and tires which shall combine strength and rigidity with an absence of all tendency to brittleness, and steel for bridges and similar structures combining lightness, rigidity, and strength. For the moving parts of high speed engines, he demands material which is capable of withstanding reversal stress under all variations of speed without risk of failure.

We have only to consider some of our modern engineering structures, such as the Forth Bridge, or a modern Atlantic liner, to see how far the iron and steel makers have done their part during the last thirty years. Not only must the steel be as free as possible from impurities, but it must also be manufactured under such conditions that it is not overoxidized, and further, that it is free from all mechanical defects. To fulfill these requirements there are two ways open to the steel makers—one to start with high price pig iron of exceptional purity, and the other to use cheaper material and purify during the manufacture. If the acid process is used, either Bessemer or

* Paper read before the Society of Chemical Industry.

open-hearth, it is well known that there is no dephosphorization or desulphurization during the operation, and to obtain a high-class product, the manufacturer is compelled to use very specially selected irons, which are costly. On the other hand, if the basic open-hearth is used to obtain the same result, he has a much wider choice as regards his pig iron and scrap, and the problem that faces us to-day is the manufacture of steel, regular in composition and free from impurities, at a minimum cost. The most promising solution in my opinion is the use of the basic open-hearth for low phosphoric or what are commonly known as hematite irons. This has frequently been suggested, and is already being done at several works in this country and various works in America and on the Continent with excellent results, and there seems no reason why practically all our open-hearth furnaces should not be basic lined irrespective of the pig iron used. I have long advocated this, and the only reason why it has not been more generally adopted, so far as I have been able to judge, is that most low phosphoric or hematite pig irons are usually somewhat high in silicon, and consequently are destructive to the basic hearth. There should, however, be no great difficulty in making pig iron of this class low in silicon and sulphur, and at one of the works referred to, iron is being made of such regularity in these respects, that it is taken direct to the Talbot furnace without being passed through a mixer. This would at once give ironmasters a far greater range in the selection of their ores, as it would no longer be necessary to confine their purchases to ores with less than 0.035 per cent of phosphorus, but anything up to 0.1 per cent could be used. In those districts where phosphoric ores are obtainable a certain proportion of these could be used with higher class ores, as absolutely reliable results in regard to the elimination of phosphorus could probably be obtained with pig irons containing up to 0.3 per cent. I am not suggesting that basic pig containing from 1 to 1.5 per cent of phosphorus should not be used, but simply that, where hematite ore or other nonphosphoric ore is at present used, these should be treated in basic-lined instead of acid-lined furnaces. Working under such conditions, either with molten metal from a mixer or with cold pig iron and scrap, the quality of the whole of our steel at present produced in acid furnaces would be improved at practically no additional, but probably at a reduced cost, when the lower price of pig iron and the less risk of rejections are taken into consideration.

The Bessemer process, both acid and basic, has done such good service in the past that one feels loth to say anything which may seem to discredit a process which has served us so well, but at the same time we must face the fact that slowly yet surely both acid and basic Bessemer converters are being replaced by open-hearth furnaces. For boiler plate and many other purposes some engineers decline to have any Bessemer steel, and even for rails, open-hearth steel is now becoming a serious competitor with the Bessemer converter, and although the present Bessemer works may continue for many years to come, it is very unlikely that any other Bessemer plants will ever be erected in this country. More especially is this the case since the recent economies effected in the working of the open-hearth practice have reduced the margin between the cost of production, and to a very great extent left little advantage with the Bessemer process in this respect.

With regard to the Bessemer basic process, this, apart from any other consideration, is restricted by the phosphoric ores available. To work this process economically it is necessary to have a pig iron containing at least 2.25 per cent of phosphorus and preferably 3 per cent, and the supply of ores to produce such a pig iron is limited to one or two districts in Great Britain.

The necessity of obtaining steel of exceptional purity for some purposes has led to interesting developments in refining in the electric furnace, and on the Continent this is being carried out at several works with marked success. Molten finished steel from either a Bessemer or open-hearth furnace is transferred to an electric furnace, where, by the addition of suitable fluxes, it is almost completely dephosphorized and desulphurized in about three hours. The furnaces are basic lined, and the refining is effected with very basic slags, the final desulphurizing slag being practically free from iron. At two of the works I visited recently, one working with the Héroult and the other with the Röchling-Rodenhauser induction furnace, the phosphorus was reduced from 0.07 per cent to 0.013 per cent, and the sulphur from 0.05 per cent to 0.004 per cent in three hours, with a consumption of about 300 kilowatts per ton of steel; an 8-ton furnace was refining about 50 tons in the 24 hours. Taking electric energy at the price it can be obtained in this country, the cost is by no means a prohibitive one. If the refining is not carried so far, less electric energy is required, and a considerably greater output is obtained. The possibilities of utilizing electric furnaces in conjunction either with Bessemer or open-hearth furnaces for the production of steel for special purposes seems to offer considerable possibilities, as not only is the steel of exceptional purity, but with careful work it can be practically deoxidized. In steel castings, too, remarkably good work is being done in the electric furnace; castings of all sizes from a little over 1 pound in weight and less than ½ inch in thickness are being regularly made, equal in soundness and quality to anything produced from the crucible, and at a considerably less cost. All grades of steels can be made equal to high-class crucible steel, and such steel is now being largely produced and competing with crucible steel. The increased size of our ingots, with the accompanying segregation troubles, makes it doubly important that we should be able to produce the purest material, and so far, the best preventive for segregation is to have few impurities to segregate.

During recent years great advances have been made in the economy of fuel in our steel works for reheating and other purposes. The adoption of the Siemens regenerative system in many gas-fired furnaces, together with the use of vertical furnaces, sunk beneath the floor level, by which radiation losses are reduced to a minimum, has been attended with great economy in fuel, reducing the losses by oxidation and the labor of charging and withdrawing. In modern practice the sensible heat of the ingot as removed from the mold is practically sufficient, if allowed time to distribute itself equally through the mass, for cogging down, and in some cases for rolling the finished product, and in gas-fired soaking pits very little gas is required for actual heating of the steel.

In numberless types of reheating furnaces great attention has been paid to details of furnace construction, both with a view to fuel economy and convenience for handling the materials, and the results have been most satisfactory.

Furnaces are now at work in which such a reducing atmosphere can be maintained that steel articles can be annealed at a red heat without appreciable surface oxidation, quite equal to anything obtained a few years ago by close annealing.

In the gas-producers, modifications in details of design, by which the proportions of air and steam are under better control, have led to more perfect combustion and considerable increase in efficiency. The producer plant in a works has been in the past and even now is not unfrequently neglected, and yet its systematic control is of the greatest importance. Not only should there be daily analyses of the gases produced, but a systematic record of the temperature of the gas as it leaves the producer, and an estimation of the percentage of carbon in the ashes, so that any losses may at once be detected and rectified.

We have now mechanical producers in which by stirrers and various other devices, the fuel is equally distributed and efficient combustion maintained, and others in which by-products are very largely recovered. The Mond producer is specially designed for by-product recovery, and the results obtained in this direction have been most satisfactory, the only drawback being the greater cost of the plant compared with an ordinary producer plant.

So far I have not referred to the question of alloy steels, and yet perhaps it is in this branch of steel manufacture that the greatest progress has been made from a metallurgical standpoint. From the discovery of manganese steel by Hadfield, to the recent developments in connection with high speed steels, there has been a record of steady progress. Our weapons of offense and defense depend entirely upon these special steels, and their special heat treatment by the metallurgist. To-day a Krupp cemented 6-inch armor plate affords resistance equal to more than 18 inches of wrought iron. There is ever the fight between the projectile and the armor, and some idea as to the shock this latter is required to resist may be gathered from the fact that the striking energy of a projectile from a 12-inch breech-loading gun is in some cases over 42,000 foot-tons, and if uncapped is capable of penetrating 19 inches of Krupp cemented armor, and if capped 23 inches. The extraordinary properties of the projectiles now made may be gathered from the fact that a 12-inch Krupp cemented plate has been pierced by a 12-inch armor piercing shell, and the projectile, after passing through the plate, has been found in the rear in a condition for bursting.

Our heavy guns are also made largely of special alloy steels, heat-treated to give them that combination of toughness and strength combined with ductility sufficient to avoid any risk of bursting.

For purposes too numerous to mention, nickel steels, chrome vanadium steels, molybdenum and other alloy steels, are used, and much of the success of our motor industry is due to the use of these special alloy steels for parts subject to vibratory and other stresses. The recent developments in high speed tool steel are so well known that they hardly need mentioning, but we have now alloy steels which are capable of cutting in a lathe at a rate of 500 feet per minute, and are revolutionizing the machine shops of the world, thus enabling the metallurgist to make some repayment to the engineer for the many services which he has rendered to metallurgy.

The progress in the manufacture of steel alloys and the heat-treatment which is essential to their successful application is largely due to a number of workers on the theoretical side. Without their labors the progress made would have been impossible. Among these may be mentioned Roberts-Austen, Osmond, Stead, Hadfield, Arnold, Le Chatelier, Guillet, and many others, who by their systematic researches on the constitution of steel and alloys have stirred the imaginations and started practical men thinking on these complex problems; and it is no exaggeration to say that their work is revolutionizing various branches of our industry. The relation between the critical points and heat-treatment, instead of being a matter for academic discussion, is now made the basis of heat-treatment in actual practice, and I could mention works where the heat-treatment absolutely depends on previous accurate determination of critical points, and the results are largely controlled by the microscope.

It is by the intelligent application and adaptation to practice of the results of our scientific men that the future of the industry must largely depend, and provided our theoretical and practical men work hand in hand, each doing his part, there is every reason to believe that future developments will in every way equal those of the past, and that the present century will show a record of progress of which we may all be proud.

THE USE OF ELECTROLYTIC FLUID IN SWIMMING BATHS.

An interesting report has recently been presented to the baths and washhouses committee of the metropolitan borough of Poplar by the medical officer of health, Mr. Frederick W. Alexander, in which the evidence appears to be decidedly in favor of the advantages gained by treating the water in swimming baths with electrolytic fluid. The fluid is obtained by the electrolysis under certain conditions of a solution containing magnesium chloride, the result being a solution of magnesium hypochlorite which serves as an efficient deodorant, oxidizer, and disinfectant. The fluid is made by the council's officers for purposes of general disinfection. The first experiments tried were made with the dirty used water in the baths before it was run off into the sewers. For financial reasons, as we have before pointed out, water in public swimming baths cannot frequently be changed, and after a number of people have bathed in the same water, more especially in baths used by persons who have no washing bath accommodations in their own homes, the water must become contaminated with organic matter and, of course, with bacteria. Further, it must be admitted that swimming baths may be used by persons who are unconsciously or otherwise suffering from communicable disease. There are, in fact, several obviously easy ways by which bath water can seriously be polluted. Mr. Alexander says that changes are noticeable in the water after it has been twenty-four hours in the baths; it assumes a darkish color, and if left in the baths grows still darker. At the bottom of the bath a slime tends to form and the bather experiences a feeling of stickiness about his body. In one of the experiments carried out with the dirty used water an excessive amount of electrolytic fluid was purposely added. The water was previously very dark in color and the bottom of the bath was obscured. A preliminary test on a small scale showed that one gallon of the electrolytic fluid added to 1000 gallons of the dirty water would just oxidize the organic matter present. Dirty water to which three times this quantity of electrolytic fluid was added showed after two hours that the organic matter had been oxidized, while there was still present an excess of electrolyzed fluid. To the bathers, it is stated, there was no evidence that an addition of the fluid had been made so far as feeling was concerned, and the taste of the water was not peculiar. In appearance the water gave distinct signs of having cleared itself, it had lost its dirty, dark-brown color, and "looked like ordinary sea-water." Chemical examination proved the absence of oxidizable matters, while bacteriological examination showed that after incubation for four days no organisms were found growing in the cultures. The cost of treatment is small, 80,000 gallons of the electrolytic fluid having been produced at the borough electrolytic plant installation during a period of four years, at a cost for electricity and materials of under $800. There can be no doubt that if public swimming baths can be treated at intervals by this simple, economical, and scientifically cleansing method, and if public experience is able to show that the water so treated is without injurious action on the body of the bather, a very valuable advance has been made.

SOME OLD-TIME HOROLOGICAL DEVICES.

FORGOTTEN MECHANISMS OF LONG AGO.

The mechanicians, and especially the watchmakers, of three or four centuries ago invented many ingenious mechanisms which have been forgotten, reinvented in some cases, and in a few instances turned to practical account without any thought of their original inventors. One of the earliest treatises on horological mechanism is the "Mirabilia Artis" of the Jesuit Father Schott, who died in 1666. Part of the work is devoted to a description of the experiments and apparatus devised by an unnamed friend of the author. The treatise was published at Wurtzburg, in 1664. Two of the plates of illustrations are here reproduced.

Plate VI shows a number of polygonal, square, oval, and rectilinear dials. Fig. 25 represents a hexagonal dial. The index, a dragon's head, is moved from or toward the center, so as to follow the hexagonal contour, by means of a "lazy tongs," *A H K C L M*, etc. A peg at *C* enters the hexagonal groove *B C D E F G*, the sections of which are parallel, respectively, to the sides of the dial.

Fig. 27 shows a square dial, with an index, *A D*, composed of two straight rods. The outer rod slides on the inner one and carries a peg which moves in the square groove. *G H T K*, causing the point *D* to follow the contour of the square dial. This simple combination of a peg and a groove has been applied to countless pieces of mechanism since the seventeenth century.

The device illustrated in Fig. 26 is far more complicated and ingenious. It is in reality an ellipsograph, and the author asserts that it may be used to trace "the ovals of Gui Ubald, well known to geometers." It comprises three superposed disks or plates. The oval plate, *A B C D*, is called the "perforated plate" (*lamina pertusa*). Its edge is marked with the hour figures and in its central portion are cut the circular hole *E F G H* and the four radial slits *E I*, *F K*, *G L*, and *H M*, the lengths of which are equal to the radius of the central opening. Over this plate, and covering the opening and slits, is the "visible disk" (*orbis conspicuus*) *O P Q L*, which is circular, except for the projection at *P*, which serves as an index. In the position represented in the drawing, the center of this disk is at *E*, at the top of the opening *E F G H*. Beneath the perforated plate and connected with the clockwork by the peg *R* is the "concealed disk" (*orbis occultus*) *M I K L*, which rotates about the fixed center *N*. A peg on this disk (at *E* in the drawing) enters a hole at the center of the visible disk, causing this center to describe the circle *E H G F* as the concealed disk rotates in the direction *I M L K*, or counter-clockwise. But the movement of the visible disk is constrained by two pegs attached to it (at *I* and *N* in the drawing) which enter the slits of the perforated plate. Hence when the concealed disk has made a quarter-revolution, carrying the center of the visible disk from *E* to *H*, the peg at *I* has moved to *N*, and the peg *N* has moved to *M*. The index consequently points to the hour mark III, and it has furthermore been continually retracted, so that it remains within the oval contour of the dial. Another quarter-revolution brings the center to *G*, the first peg to *L*, the second peg back to *N* and the index to VI. The rotation of the visible disk is clockwise, though its center revolves in the opposite direction.

Figs. 28 and 29 represent dials on which the hour marks are arranged in horizontal lines. In Fig. 29 the image of the sun *K M* is caused to move alternately to right and left by means of the wheel *A B C D E F*, which is toothed on one-half of its circumference and engages alternately with the pinions *A* and *D*. The common axis of these pinions carries two other toothed wheels, *G* and *H*, each of which engages with a rack on one of the long sides of the rectangle *I K L M*, which carries the sun, or index, *K M*. The hour marks are arranged in two horizontal lines, above and below the rectangle, numbered from left to right above and from right to left below. A simpler rectilinear dial is illustrated by Fig. 28. An endless cord connects two equal wheels driven by the clockwork. The cord is divided into six equal parts, and "flexible obstacles" are attached to it at the alternate points of division *A*, *F*, and *C*. The index *G* extends across both branches of the cord and is moved to and fro, between the limits *A C* and *B D*, by these "obstacles." For example, the obstacle *A* carries the index to the position *B D* and leaves it there. Meanwhile, however, the obstacle *F* has moved to *D*, and it immediately catches the index and carries it back to *A C*. This system was published as a new invention in 1717, forty-three years after the publication of Schott's book, by Abbé de Hautefeuille, the celebrated adversary of Huygens.

Among the many odd and mysterious timepieces constructed about fifty years ago was one in which a cylinder rolled down an inclined plane in 12 or 24 hours. The same device is shown in Fig. 42 of Schott's Plate VIII. A somewhat similar contrivance, in which a metal ball rolls incessantly down a zigzag groove in a rotating cylinder, is illustrated by Fig. 40, and the groove is shown, enlarged, in Fig. 41. A still more remarkable mechanism, in which a truncated cone rolls down a helix, is represented in Fig. 43.

Fig. 44 shows a clock without geared wheels, in which the action of the weight upon a series of wheels connected by knotted cords is regulated by a pawl *M A*, which is attached to the pendulum *M N P* and allows one knot of the cord to pass at each oscillation. It is needless to add that this clock would go only on paper. In Schott's time the researches of Huygens were not generally known. Despite his travels and his learning, the good priest clung to large oscillations and imposed impossible tasks on his pendulums.

Figs. 45, 46, and 47 illustrate methods of maintaining the motion of clocks by the agencies of fire, air, and water. In Fig. 45, the globes *M* and *L* are supposed to be filled with air, while the large globe and the tank *P R* contain mercury. By heating the small globes part of the air contained in them would be forced into the large globe, compelling the mercury either to rise in the tube *D C* and lift a weight, or to overflow into the tank, in either case furnishing a source of power which could be employed to wind a clock. Various methods of maintaining the movement of clocks by the dilatation of air, water and other fluids have been patented within the last half century.

The same statement is true of clocks driven by the wind. In Schott's device (Fig. 46) two pawls, attached to a weather vane, engage respectively with right-handed and left-handed ratchet wheels mounted on a common axis, which is, consequently, turned in the same direction by a shift of the wind in either direction. Finally, Fig. 47 represents a wheel with double feathering paddles which rotates when immersed completely in a stream of water because the paddles, or buckets, automatically open when they move with the current and close when they move against it.

Among Schott's many ingenious inventions are a spit turned by the smoke of the kitchen fire, and a device for winding clocks by the passage of men, horses and vehicles over a movable sill at the door or gate of the house.—Cosmos.

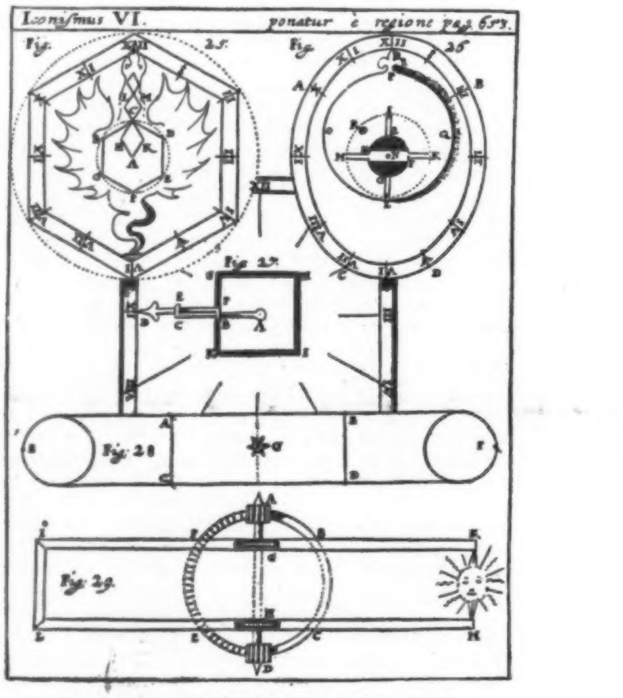


Plate VI.—POLYGONAL, OVAL, AND RECTILINEAR CLOCK DIALS.

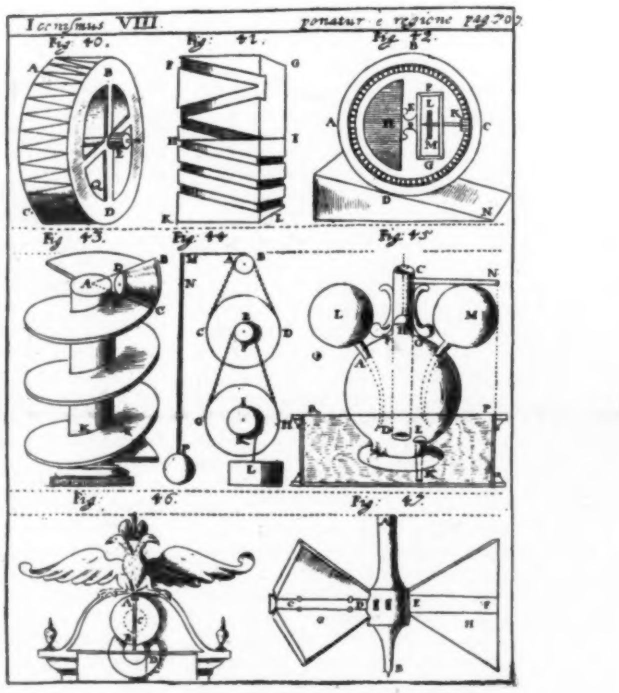


Plate VIII.—ODD CLOCKS AND CLOCK-WINDING DEVICES.

FOREST WORK ON THE VANDERBILT ESTATE.

In point of variety and scope the forest work done on the Biltmore estate, in North Carolina, is remarkable. The forests, which cover 130,000 acres, are made profitable by the production of various forms of material. Four million feet of lumber, 5,000 cords of tannic acid wood and fuel, a thousand cords of tan bark, and several hundred cords of pulp wood are cut every year. At the same time the forest, through wise management, is bettered and is steadily increasing in value. Workmen employed along the boundaries of the forest do duty as fire guards. Thus fire protection is secured, at least throughout all the accessible parts of the tract. In connection with all lumbering operations permanent logging roads are built. These minimize the present cost of transportation, and will greatly reduce the cost of marketing future crops and, moreover, they will serve as a network of fire lines.—Railway and Eng. Review.

A thoroughly modern installation of aluminium lightning arresters has been recently put into use to protect the transmission system of a generating station on the Hoosic River, N. Y. From this station 12,000 kilowatts at 32,000 volts are transmitted to works at a distance of 21 miles. The transmission lines are in duplicate, and are supported on specially constructed steel towers fitted with the link type of suspension insulator. A 3/8-inch stranded steel cable earthed at each tower is supported above the transmission wires as additional protection against atmospheric discharges.

AMERICA'S LARGEST DOME.

ERECTED WITHOUT SCAFFOLDING OR FALSEWORK SUPPORT.

The dome just erected over the four great arches of the Cathedral of St. John the Divine is an engineering feat that is attracting general attention. This is one of the largest masonry domes in the world, being about 135 feet in diameter, measured across the lower part of its spherical surface. Its crown towers some 200 feet above the floor of the building.

It was built entirely of burnt clay slabs $6 \times 15 \times 1$ inch bonded with Portland cement mortar into a monolithic dome shell of unprecedented thinness. While many somewhat smaller domes have been erected of these materials, this is the first one in the world built without staging or falsework of any kind. The work was self-supporting from the beginning.

The thin terra-cotta slabs were laid up edgewise in successive circular layers. The joints broke vertically and laterally, and forming a hemispherical dome which surmounts the four great granite arches, 145 feet high, 12 feet in depth, each having a clear span of 85 feet, as the base for its support. The novel method of construction adopted not only saved great expense, but also obviated the risk incurred by the erection and removal of heavy staging and falsework.

The lower portion of the dome springs from the four corners of the square formed by the junction of the great granite arches. From these four starting points upward the successive layers of tile widen rapidly over the curve of the great arches, converging in a perfect circle at their crown. From there the work was carried up at a uniform height until the crown was reached.

The inner layer of tiles was laid in mortar of plaster of Paris, which, by reason of its quick setting, immediately gave this layer sufficient rigidity to act as a template for the successive layers above, which were laid in rich Portland cement mortar.

The vertical and lateral curvature to which each course should be laid was determined by stretching heavy steel tapes from the established center point to the interior dome surface. These tapes being marked for one-half the diameter, instantly indicated the exact position where each tile should be laid to form its part of the hemisphere.

To establish this center point, ¼-inch cables were thrown across from the center of the crown of each of the four great granite arches, intersecting at right angles exactly in the central point of the dome's diameter. This point was accurately determined by the engineers with transit and level observations. Turnbuckle attachments rendered it possible to adjust for temperature variations. At this intersection a steel plate 4 inches square was attached to the cables, having in its center a hook from which a fifth cable extended to an 800-pound weight at the floor, acting as a guy to maintain the center point in position. The threaded end of the hook extending through the plate served for the attachment of the tapes used to indicate the circumference of the dome and the hemispherical curvature at any point during its erection.

The work progressed rapidly, and the materials combined and sustained their weight and that of the mechanics without the slightest mishap or irregularity. According to every known theory, it seemed that work erected in this manner would fall of its own weight; but each morning as the artisans resumed work the material laid the previous day was found to have acquired such rigidity as to be capable of supporting their weight and sustaining the fresh construction as they continued onward toward the top.

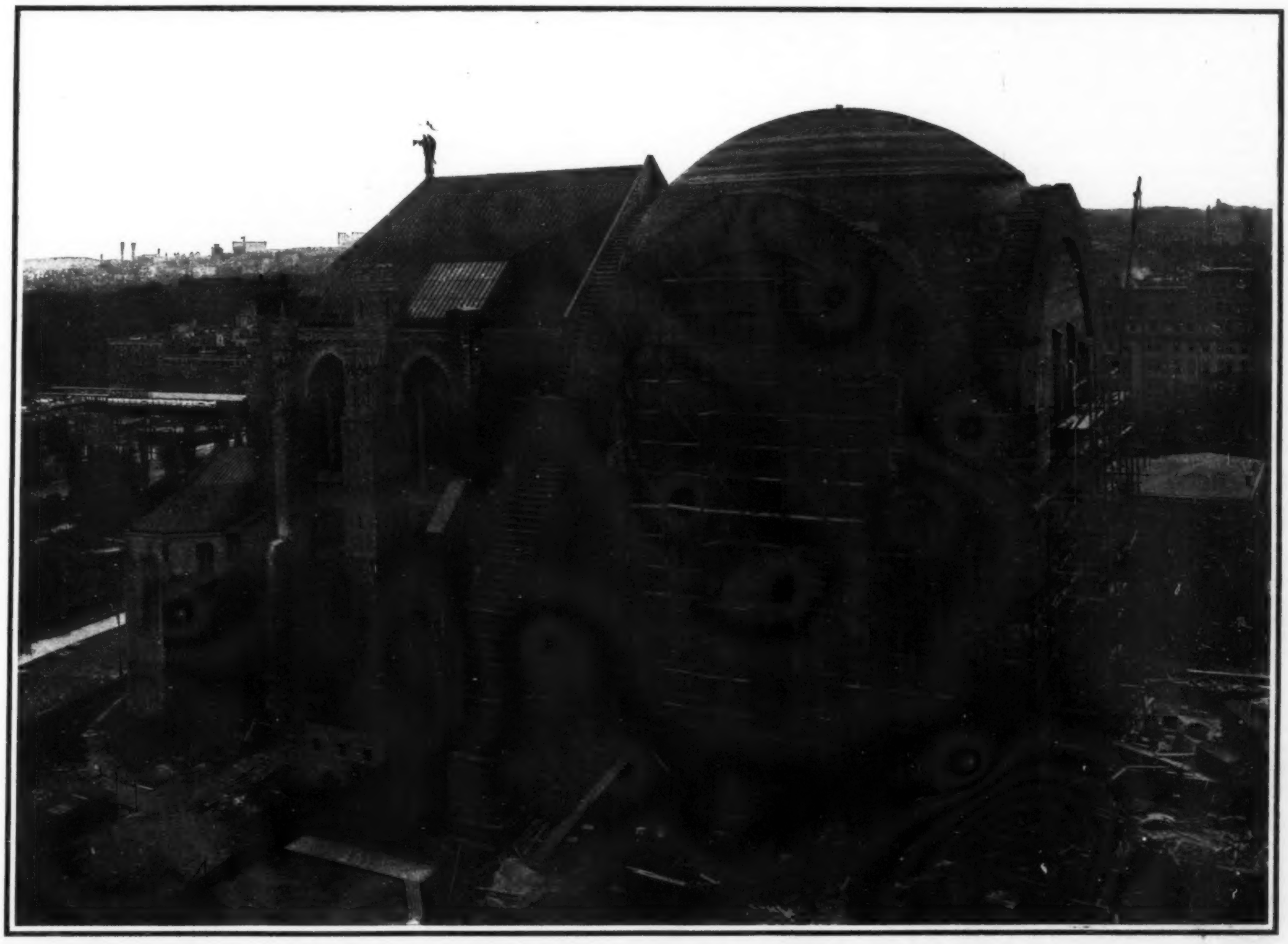
This great dome, which was erected in a few weeks' time, compares very favorably in size with the world's largest domes. The greatest of all, the Pantheon at Rome, measures 142 feet in diameter. St. Peter's at Rome and the Duomo at Florence are about 139 feet. At Constantinople there is the dome of St. Sophia's mosque of 115 feet diameter, and the dome of St. Paul's, London, measures some three feet less.

To appreciate the great advance in masonry construction marked by this new cathedral dome, it is necessary only to refer to the history of the erection of the earlier domes mentioned. Years and endless trouble attended the building of these domes, not to mention the expense and loss of life incurred in the preparation of the falsework necessary to sustain the work during erection. Even after the dome was constructed the supports had to remain in position until the materials had set.

While the shell-like thinness of the cathedral dome, according to the usual methods of computing the strength of masonry vaults, would seem to render it inadequate to carry even its own weight, this dome is destined to sustain a heavy wind and snow load.

The dome is six courses of tile in thickness at the base, or about 7½ inches, decreasing to three courses or four inches at the top. In comparison with other famous domes its thinness is remarkable. This system of tile construction was invented by the elder Mr. Guastavino, a Spanish architect engineer, who came to this country to practise some thirty years ago.

The Cathedral of St. John the Divine, which will cost about ten million dollars, has been under construction some fifteen years, and will be the largest of its kind in America, being 520 feet in length by 280 in breadth, taking the form of a cross, as is usual in large cathedrals. When completed, it will accommodate ten thousand people.



AMERICA'S LARGEST DOME ERECTED WITHOUT SCAFFOLDING OR FALSEWORK SUPPORT.

An American consular report states that with the completion of the second section of the municipally-owned electric railway at Osaka, nine miles have been opened to traffic. This includes a line three miles in length to the harbor. Work is now being commenced on the third section—32 miles—and a fourth section—13 miles—is also contemplated. Osaka will eventually be linked with all the neighboring towns by an electric railway system. Connection with Kobe—the Haushui Electric Railway—and the Hawadera—a seaside resort 15 miles distant on the Nankai Railway—has already been established. It is now proposed to electrify the rest of the Nankai Railway to Wakayama, 40 miles distant. Electric railways to Kyoto and Arima, mineral springs and summer resorts in the hills on the northwest, are also under construction.

SELECTIVE ECONOMY IN RAW MATERIALS.*

TURNING WASTE TO PROFIT.

BY HARRY S. MORK, ENGINEERING CHEMIST ARTHUR D. LITTLE LABORATORY.

Where a true selective economy is exercised in the purchase of raw materials, the choice is not determined by either quality or price, but by the relative industrial efficiency of the materials under consideration. The opportunity to economize may therefore lie in the substitution of a high-priced material for a cheap one; in a change from a coal which the fireman likes to one which gives more heat for a dollar; in selecting lubricants with reference to their physical constants instead of by brand; or, very commonly, in discarding altogether some particular material long in use in favor of another more efficient at the price.

Large industrial corporations provide and maintain purchasing departments, the duties of some of which apparently end when the necessary materials have been purchased from the customary source of supply, or at the best offered prices. To meet its full responsibility, and rise to its proper place in the organization which it serves, the purchasing department must have a much broader aim, and must search for and investigate every possible chance for economy which may have its origin in the source, properties and group relationships of available raw materials, no less than in their price. That so many purchasing departments voluntarily limit their scope and fail to grasp their opportunities, is explained by several reasons, of which the more important are:

First, lack of knowledge on the part of the purchasing agent of the fundamental chemical or physical qualities which make the material suitable. To be sure, the majority of purchasing agents are not technically-trained men, and cannot be expected to know many of these qualities. Consequently they cannot adequately appreciate what the market affords in materials with the suitable fundamental properties, especially when these are not obviously characteristic.

Second, ignorance of the group relationships of particular raw materials with other materials, which are thus overlooked, though equally available.

Third, lack of knowledge as to the source or origin of the specific materials offered. It is easy to pay too much for wood pulp under the name of filter masse, or for waste soda pulp liquor when buying boiler compound, or for type foundry waste when it appears as a special bearing metal.

Fourth, the tendency to adhere to the raw material standardized years previously, because it has been demonstrated by long experience that it will do the work satisfactorily. While such an attitude does have its points of justification, far too often the case is one where great economies can be effected, but where the opportunity is unrecognized or lost.

Finally, and most important as the common underlying cause of all the others, the unwillingness to learn so often shown by those who should be broadest, but who are stubbornly and persistently narrow and intolerant of the views of others whose school may not be of such long experience, but rather of more varied training and more advanced thought.

Organized and co-operative effort is essential to the success of every large industrial concern. Without it there must be unnecessary losses. It certainly cannot be neglected in the selection of raw materials. For best economy there must be co-operation between the purchasing department and every consuming department, and especially should there be co-operation with the industrial chemist and chemical engineer, whose business it is to keep abreast of the rapidly-changing modern conditions of production, and who is in position to follow the course of a material from its first manipulation to its ultimate use, through many different processes and varied applications.

True it is that a material is strictly raw only when it is used unaltered in a manufacturing operation, but "raw material" may be defined broadly, and is here considered as any material the regular or periodic consumption of which is essential to the manufacture of a finished product. In the majority of instances the raw materials of one industry are the finished products of another, as, for example, wood pulp, bleach, alkali, flour, oils, glue, and paper.

In accepting the above conception of raw materials it becomes apparent that these may be derived from various sources. They may be obtained from natural resources or they may be the result of a manufacturing process, of which they may either be the primary product, a by-product, or a waste. This last source is not by any means of slight consideration, and the history of the last few years has shown that live men are now awake to the great possibilities of large profits to be derived by successful utilization of wastes as raw materials in their own or other industries.

Raw materials may be classified in a number of groups, the factors to be considered in economical selection differing for these various groups. Such a classification may be made as follows:

First, materials which are simply refined.

Second, materials which become a component part of the finished product, undergoing varying degrees of alteration.

Third, where no part of the raw material appears in the finished product.

As simple examples of the class where the material is refined, we have raw sugar, which goes through the various processes of solution, filtration, decolorization, crystallization, and granulation, in its conversion into granulated sugar; crude camphor, which has to be resublimed before it can be used in celluloid manufacture or as a drug; bauxite, or native alumina, which must be freed from iron and otherwise purified before it can be used in the electric furnace manufacture of aluminium, or in the production of the high-grade papermaker's alum; crude argols from which is prepared cream of tartar.

In selecting materials of this class which shall be the most economical, much more than the mere price must be considered. The instances in which the lowest-priced material is actually the best are few in comparison with the many cases in which a higher-priced material is really the cheapest to purchase, because of its greater industrial efficiency. Moreover, if the goods are bought at the source of supply, differences in freight rates and losses in transportation influence decidedly the cost at the mill. The American cotton bale is so poorly put together that very few bales reach their destination intact, and the losses of cotton are sometimes so considerable that the evil is a subject of constant agitation. Cases are known where sections of railroads have practically been ballasted by the iron ore which has dropped from the cars. Liquids which are transported long distances in barrels or casks rarely net the same at their destination that they do at the point of shipment, and allowance must be made for leakage, the burden invariably falling on the consignee.

When the proper allowances have been made, and the cost of the material delivered at the refining plant is determined, the next factor to be considered is the percentage of refined product the raw material may be expected to yield. A chemical analysis will tell a great deal as to possible maximum yield; in other words, it will tell exactly how much of the desired ingredient is present, and will very probably tell how this is associated or combined with the other constituents. For these reasons an analysis is exceedingly important. It is, however, only a relative indicator of cost, as the nature of the impurities may be such that their removal can be effected only at a great expense, or be accomplished only by a considerable sacrifice of that portion of the raw material it is desired to preserve. Frequently it occurs that the valuable component of the raw material is so combined that its separation necessitates much more expensive processes than the separation of the same component from a material in which it is differently combined. In such cases economy is determined not only by percentage composition, but by cost of separation. The mineral industry furnishes many examples of this nature. Many ores containing valuable metals in considerable amount are far more expensive to work than other ores of much lower assay. An iron ore analyzing high in iron, but also relatively high in phosphorus, is more expensive to work than a lower grade ore with low phosphorus content.

The second class includes such materials as textile fibers, pigments, waxes, varnish, gums, wood pulp, oils, and dyes; or, more specifically, raw cotton fibers are spun into yarns and woven into fabrics without the chemical composition of the original fiber being altered. Shellac is dissolved in alcohol to make a varnish, but it still remains shellac.

This class includes also materials which in becoming part of the finished product are chemically altered, like naphthalene in the production of synthetic indigo; sulphur, or pyrites, in the manufacture of sulphuric acid; ores; cotton in the manufacture of soluble cotton; oils and alkali for the manufacture of soaps; and so on. When naphthalene is converted into artificial indigo, it is first changed into phthalic acid, an entirely different chemical compound. When sulphur is converted into sulphuric acid, the first operation is to burn or oxidize the yellow sulphur with which every one is familiar into the colorless, stifling gas, sulphurous acid. In these two examples, the original substance is not only changed chemically, but also altered physically in a very marked manner. When, however, ordinary absorbent cotton is changed into highly explosive gun cotton, the cotton is converted into a different chemical compound, cellulose nitrate, but practically retains all the appearance of the original cotton.

As in the case of materials to be refined, location of the source of supply, freight, and transportation losses are important. It is also absolutely necessary that sufficient supply be available. It is no use to select one of several materials because it is the lowest priced, even if the other economy factors are equal, when the supply of the cheaper material may at any moment be cut off, especially when the margin of profit of the finished product is small, and the finished product is sold under a rigid contract.

The yield of finished product is obviously of prime importance. Directly associated with this is the quality and character of the waste. The value of a waste is in many instances just as vital a factor in determining the volume of profits as is the purchase price of the raw material itself. The price which can economically be paid for pyrites in the manufacture of sulphuric acid is often determined quite as much by the proportion of copper in the slag as by that of sulphur in the original material. Textile fibers offer an excellent example, for the short waste fibers from the pickers, and the card, and the combs, are a direct source of income to the mills. The conversion of blast furnace slag into cement affords another fine illustration, and the utilization of blast furnace gas for heat and power is now a very ordinary occurrence. The extraordinary statement has been made that in the not very distant future the blast furnace will be operated for the gas it produces, and that pig iron will be a by-product.

The opportunities for utilization of wastes are still many, and the conversion of a waste into a commodity means increased prosperity to the community. If all the flax waste straw lying valueless in the West were converted into halfstuff or pulp for paper, it would mean a great deal to the farmer and much to the papermaker. If it were possible to utilize all the waste cellulose which grows each year and which is either burned or rots away, as the cotton stalks of the South, or the cane brakes of Louisiana, the problem of the preservation of our forests would be much simplified. Of lesser scope, but deserving of equal consideration, is a waste which is the direct result of some mechanical operation or of some chemical process. To use such wastes adds to profits; not to use them may mean direct financial loss, for should the waste become a nuisance the way is paved for litigation and damage costs, or for the expense of relocation.

It may be of interest to indicate how a number of manufacturing wastes have been turned to profit. Sawdust can now be burned with facility under a boiler; its fuel value is about 40 per cent of the average coal. Treated with alkali, it produces oxalic acid; and when pulverized it becomes useful as a substitute for ground cork in linoleum manufacture, or an absorbent for nitroglycerine in the production of dynamite. Tin-plate scrap has for a number of years been a marketable product; the tin is removed from the sheet iron either chemically or electro-chemically, and both tin and iron find a ready market. The waste liquors from iron and copper pickling vats are now used as precipitants in the purification of potable waters. The waste wort from the modern malted breakfast food factories is fermented to vinegar. Gluten is made from starch factory wastes, lemon oil from the peel of culled lemons, wrapping paper from sulphite pulp screenings, and so on.

In selecting a raw material it is equally necessary to estimate how large an item of expense will be the labor and the power required to convert it into the market product. It not infrequently happens that the labor and power costs are in excess of the cost of the raw material. Consequently it is not economy to select the cheapest stuff to be found if it takes a disproportionate amount of labor to use it. In selecting a paint as a protective coating for either iron or wood, the cheapest paint will probably prove the most expensive when measured by the number of coats necessary to apply and frequency of renewal. There are of course cases where cheaper materials do sometimes require less labor in their conversion into the finished product. Lead in copper bronzes reduces the

* Presented at annual meeting of the American Chemical Society, New Haven, Conn., July 3rd, 1908.

cost, and also makes them much more easily machined. A trolley wheel containing several per cent of lead is much more easily turned than one without lead. As to the mileage such wheels will give is quite another question, and it is probably now generally conceded that high lead means short life.

The third class, in which no part of the raw material appears in the finished product, embraces substances of very diverse character and functions. It includes all materials which are catalytic in their action, like platinum. A catalyzer is a substance which by its mere presence increases the rate and efficiency of a chemical process without itself suffering any change. Closely allied are those materials which assist in the formation of the product, and are subsequently recovered, such as sulphuric acid in the manufacture of artificial essences and flavors. Here, the acid acts as a dehydrating agent, absorbing the water which is formed by the process, and ultimately becoming diluted to a point where it is no longer efficient. Quite different, but in the same broad class, are certain solvents such as acetone, alcohol, ether, etc., used in producing photographic films; or extraction solvents, such as naphtha in recovery of wool grease. In the first group the solvents, which are subsequently recovered, are used to alter the physical form of some other material; in the second group the solvent merely traverses the material and removes therefrom, without otherwise altering it, all substances soluble in the solvent. Some materials react on the basic raw material, and are themselves altered, but subsequently recovered. This is illustrated very well by the ammonia used in the manufacture of carbonate of soda, by the ammonia soda process, and by the soda liquors of the soda pulp manufacture. There are also materials which produce an effect but are themselves destroyed, such as bleaching powder or the sawdust which is mixed with clay in forming porous terra cotta, and afterward burned away in the baking.

The most important materials in this class are those which never come in contact with the finished product during any stage of its manufacture, but which are absolutely essential to its production. Examples of such raw materials are found in lubricating oils and coal. This classification refers to coal used for power; gas coal and coal for coke fall more properly in the class where the material becomes part of the finished product with chemical alteration.

Coal is so universal a raw material, and coal economy so important and such a specialized subject, that an extract from a recent publication of this laboratory is well worth quoting. It says: "In buying steam coal the amount of heat that may be developed from it is the measure of its value to you. There is no by-product that may be utilized, except that in some cases the sale of ashes might be considered in this connection, but their removal is generally an additional expense. Two coals at the same price and containing the same number of heat units may not be equally desirable. The difference in volatile matter might cause the lower to prove more satisfactory under certain conditions of smoke restriction, while the higher volatile coal would probably be more applicable in a plant with fluctuating load. The amount and nature of ash in regard to the formation of clinker often need to be considered.

"The liability of spontaneous combustion of one coal more than another, may make it advisable to pay several cents per ton more for one coal containing no more heat units than the other."

Referring to seven different coals, the analysis and results of evaporative tests of which are tabulated, this publication shows that of the seven neither the intrinsically best nor the lowest-priced coal would be the cheapest to buy.

As for lubricating oils, opportunities for economy can be found in most factories. In one of the largest corporations in the country, an expensive cylinder oil was being used on its machinery where a heavy machine oil would have answered equally well, with a saving of over $2,000 per year. There are many instances where equally efficient but cheaper oils can be substituted for more expensive ones; this is particularly true of cutting oils. But probably the greatest source of saving will be in the knowledge that one mill will be using the identical oils that the mill next door is using, but is only paying two-thirds the price for them.

Of the other materials of this class, which are no part of the finished product, economic selection is determined by the original cost, the relative power to do the work, the ease of recovery, the amount recoverable, and the effect on the apparatus and workmen. Carbon tetrachloride is a solvent which is much more expensive than naphtha; it has anæsthetic properties similar to chloroform, consequently the workmen must be protected from its vapors; it also has slight corrosive action on iron containers; but it has the immense advantage of being non-inflammable, while naphtha is exceedingly combustible and forms highly explosive mixtures with air. The property of non-inflammability reduces the fire risk and effects a saving in insurance. Insurance, although compensating for actual property destroyed, rarely makes allowance for loss of business during reconstruction.

Looking at raw materials broadly and without classification, there are a number of points of special interest. As stated before, the cases in which the lowest-priced material is actually the cheapest are few in comparison with the number in which the higher-priced material is really most economical. Of the former, mention can be made of synthetic indigo, which is not only cheaper than natural indigo, but is also better. If the hopes of the indigo planters are realized, improved methods may enable them to reverse this condition. Sulphate of alumina is cheaper than crystal alum, and when valued on its alumina content is much more efficient; retort carbon at five cents is better as an electrode for aluminium manufacture than graphite at fifteen to seventeen cents; ultramarine is cheaper and better than smalts. In the latter case, in which high-priced materials are most economical, mention can be made of carborundum, which costs more than emery, but has far greater efficiency. A cheap Babbitt metal is more expensive than a higher-priced one, if its intrinsic value is commensurate with its price. Steel trolley wheels have a cheaper first cost than bronze wheels and give a longer mileage, but serious wear on the trolley wire, and the high loss of power through resistance, probably more than compensate for the difference in first cost. Copper generally, but not always, has a higher industrial efficiency as an electrical conductor than iron. Under some conditions of price and service aluminium should be preferred to either. Carloads of sal soda have been used because it costs less than soda ash, and because of ignorance of the fact that it is only three-eighths as strong. The balance is just water, what is known as water of crystallization, which in itself never makes crystals appear moist or wet, and which, therefore, is not obviously present.

This example introduces another element of consideration. Every manufacturer realizes that water costs something, but it does not cost as much as soda ash, or as much as paint, or as much as the sizing dissolved in it. Dry materials are better because they are really cheaper, because the freight bill will not be so large, because they are more uniform, and because you know what you are actually paying for. If it is necessary that water be present, the purchaser can himself add it to better advantage.

There are many instances where cheaper materials have been substituted for more expensive ones without decrease of efficiency, and the field for economic substitution is still very large. Casein has taken the place of glue in paper coating, celluloid the place of hard rubber, and kerosene the place of whale oil. On the other hand, the composition or quality of the finished product frequently determines the selection of a raw material. For a very white, high-grade paper a hydrate alum, practically free from iron, must be used; for a lower grade paper a bauxite alum will answer to every extent as well. Ground wood papers have their field in ephemeral publications, but have no place where permanency is essential. Caustic soda will make good hard soap, but the more expensive potash is required for soft soap.

It is to be regretted that it should ever happen that opportunities for economy are lost, because some one in the organization sacrifices his integrity and loyalty to personal gain. The textile chemical dealers probably have to meet this unfortunate condition more frequently than almost any others, but they are by no means alone. It is difficult to say, where such conditions exist, who is the more to blame, the salesman who, to push his goods, makes presents or allows secret commissions to the purchaser's employees, or the dyer or engineer or pressman who allows himself to be so easily corrupted. All are doing just so much to undermine the industrial efficiency upon which the welfare of the whole community depends.

The highest possible industrial efficiency, measured finally, as it must be, in terms of dollars and cents, although involving many other factors and leading to greater and better ends, is in the last analysis the test and object of selective economy in raw materials. It is the duty, as it is daily becoming in larger measure the privilege, of the industrial and engineering chemist to raise the standard and increase the output of productive effort, and in no way does he do this more effectively than by enabling the manufacturer or the purchasing agent of a public service corporation to properly evaluate and control the quality of his supplies, helping him in the selection of the most efficient, and, therefore, the most profitable of available materials, and insuring to him by chemical control that the selected material is, in fact, delivered and held to quality in every shipment.

PACIFIC COAST STEEL INDUSTRY.

By Gibson Arnoldi.

Considerable interest attaches on the Pacific coast to the prospect of the early completion of its first modern steel plant at Irondale, Wash., on Port Townsend Bay, at the entrance to Puget Sound. The plant means much to the western part of the United States and British Columbia with their wealth of minerals and coal. The importance of the plant is fully realized by the people of the West, and this because of the present high price of steel on the coast, due largely to the heavy freight rates from Pittsburg and St. Paul.

As to the need for such a plant, there can be no question. Freight rates to the coast from Pittsburg range from about $16 on castings to $23 a ton on finished steel. This high freight in itself provides a tariff in favor of Pacific coast steel which Pittsburg can never overcome, and as scrap steel has been accumulating for years in large quantities, it can be bought on the coast for less than $10 a ton delivered at the new plant. Similar scrap steel commands about $16 a ton at Pittsburg.

The works of the Irondale Steel Company will be completed and in operation by the latter part of this year. In addition to the blast furnace of 100 tons capacity already completed, which was designed and built by the Wellman & Seaver Company of Cleveland, Ohio, the company is rapidly installing four 25-ton basic open-hearth furnaces, two of which are practically completed. The product will be rolled into I beams, channels, angles, small rails, shafting, and all kinds of merchant steel in rolling mills now being installed. The sizes of the rolling mills will be one 22-inch three-high mill, one 14-inch three-high mill, and one 9-inch three-high mill. The Irondale Steel Company is also installing a butt-weld tube mill for manufacturing pipe from ¼ inch to 3 inches. It is also installing a galvanizing plant in connection with the tube mill.

In the sixty-four years of its existence, it has been the privilege of the Scientific American to record the establishment of many of the principal industries of the United States, many of which have since grown to proportions far beyond the expectations of those who were instrumental in their first establishment. It is impossible to foretell what the establishment of a steel plant on the Pacific coast among the great coal and iron beds of the State of Washington and the Province of British Columbia, Canada, will demonstrate. That there is coal and iron in abundance cannot be disputed. Experts have had much to say both for and against the quality of the coal and iron. In answer to criticisms, the Pacific coast people claim that it is against the interests of the Pittsburg industries to have a steel plant on the Northwest Pacific coast, and this was the chief reason for unfavorable criticisms. It is apparent that the establishment of a complete modern plant is a matter of the greatest importance to those interested in the mining and coal properties of the Pacific coast, and as it is claimed that both the hematite and magnetite ores compare favorably with eastern ores found in the Lake districts, the results obtained will be awaited with interest. The magnetite ores contain from 59 to 68 per cent metallic iron, while the hematite ores contain from 45 to 55 per cent metallic iron. The magnetite ore is all Bessemer ore and extremely low in phosphorus. A great many of the deposits of magnetite are self-fluxing, while the eastern ores are high in silica, which requires a great deal of limestone in the blast furnace to flux off the silica. The magnetite ores are probably the easiest to mine in America, consisting of the huge surface deposits, which range from 30 feet to 200 feet in width and to 400 feet in depth.

The hematite ores are obtained in the State of Washington in Snohomish and other counties, and there are large deposits of hematite located on Quatsino Sound, Vancouver Island. This ore is known as bog hematite, and originated from the decomposition of iron sulphides. These deposits have been largely developed. The development work consists of pits, trenches, open cuts, and other usual work. Most of this ore can be steam-shoveled and put on board the steamer for 30 cents per ton, and delivered at Irondale for $1.80 per ton.

As to limestone, there is also an abundance of this necessity, and it is perhaps the purest to be found anywhere in the United States. Experts report that it will average between 98 and 99 per cent precipitate carbonate of lime, and is found in immense deposits close to rail and water transportation in the San Juan Islands and Cascade range of mountains close to the Irondale Steel Works. It can be mined and delivered at Irondale for about $1.25 per ton.

As to coal, the company has already acquired extensive coal deposits, upon which over $140,000 has been expended in prospecting and tunnel work. The property is located at Ashford, Pierce County, Wash., on the Tacoma & Eastern Railroad, 55 miles from Tacoma. It is a high-grade coking, steam, gas, and domestic coal running from 60 to 65 per cent carbon, high in volatile matter and low in sulphur.

THE SECOND PARIS AERONAUTICAL SALON.

AN ANALYSIS OF THE TYPES—MONOPLANES, BIPLANES, DIRIGIBLES, AND ENGINES.

BY R. P. HEARNE

An unexpected turn of events has caused increased attention to be given to the Paris aeronautical salon, or at least to the aviation section of it. The "République" disaster was taken to be a further proof that the day is rapidly approaching when dirigible balloons will be superseded by aeroplanes for military purposes. As it happens, the airship display at the salon is very meager, and the few vessels on show are of types inferior to the "République." Thus the triumph of the aeroplane was all the more clearly suggested to its votaries.

The "Zodiac" is the only full-sized airship shown, and it is too small to be of any use in warfare. Some interest attaches to the "Don Simoni" large-size model airship, as the vessel itself is to be engined with a powerful Wolseley motor. There is also a highly interesting model of the "Spiess" rigid airship, which, it is claimed, was invented by a Frenchman in 1873. Spiess had the idea of making a vessel with a lattice woodwork frame inclosing a series of gas bags in a fashion similar to that adopted by Zeppelin. He also provided for four propellers, two mounted on each side of the vessel itself. If his claims are borne out he may be shown to have anticipated Zeppelin in many important respects. It is now proposed to build a full-size machine on improved lines. As the French experts have quite suddenly discovered some merit in the rigid type airship, the scheme has greater possibility of succeeding than it had before the "République" was destroyed.

Leaving the aerostatic section of the salon we may first consider the monoplanes as well by reason of their numerical superiority as by the fact that they are most typical of the French school. France seems destined to carry the development of the monoplane to its highest degree, and the machines on view show how many different paths may be followed. From the public point of view Santos Dumont has shown the most alluring way, and his little "Demoiselle" attracts as much, if not more, interest than Blériot's cross-Channel machine. There is fascination in the idea of having a flying machine of hardly 20 feet span, and not very much heavier than a fully equipped motor-bicycle. It would cost less than many a motor-car, too.

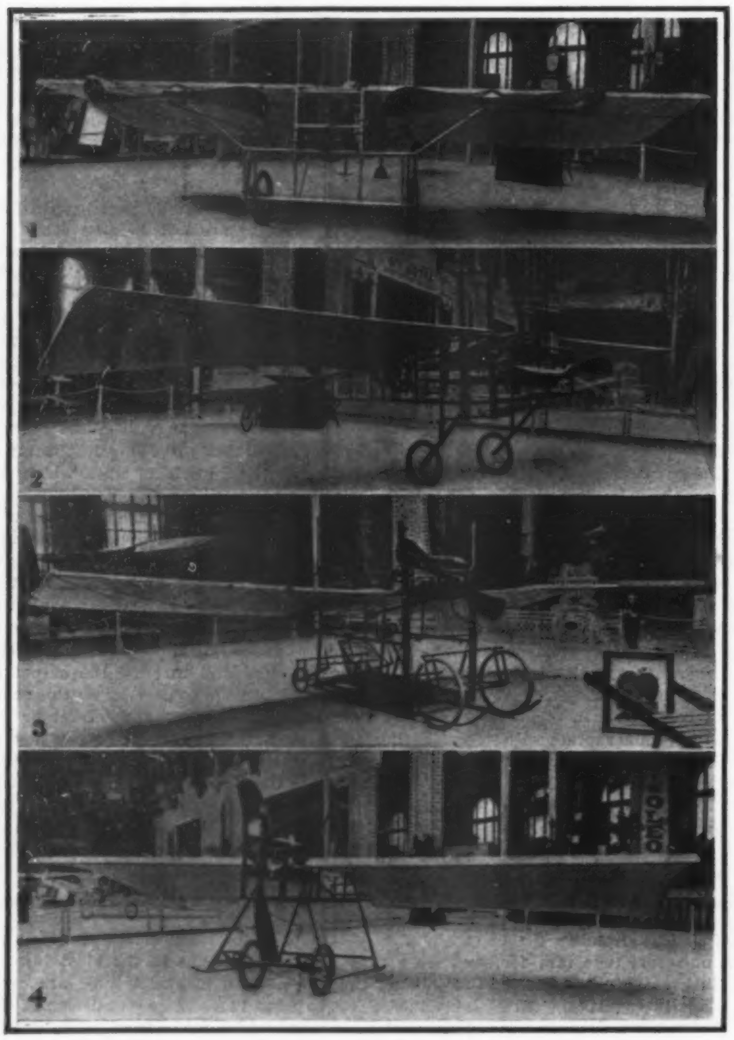
The whole design is very ingenious, and it is full of little peculiarities, all leading up to weight saving and efficiency. The engine is mounted above the plane, and conspicuous features of the underside of the plane are the cord-like strands of the radiator. Only a Santos Dumont would have thought of incorporating the radiator with the plane itself. The control is most ingenious too, wheel, hand lever, and stirrup being employed. The engine is the new horizontal Darracq, and this is responsible in no small degree for Santos Dumont's success. But ordinary people must not think that on this little machine they will be able to equal the exploits of the clever, daring, and featherweight Brazilian.

The opposite pole of development is typified by the great Antoinette monoplane, with its 100-horse-power engine. Here we have grand proportions, which compare with Dumont's machine as the eagle with the swallow. There has been no question here of paring down the weight or the dimensions. Ample proportions and power are given; and the long lithe body of polished wood, the broad, staunch wings, the immensely strong under chassis, and the great front skid, like the beak of a monster bird, combine to give a suggestion of grand power and speed. The new machines are really beautiful pieces of work in every respect. Their system of wheel and pedal control is also quite the best thing yet achieved.

A unique display is made by the Blériot firm, for in addition to showing the cross-Channel flyer, they put on view three other specimens of their handiwork. One of these is of the cross-Channel type, the other is a larger machine capable of taking two people; and there is also shown the central body in skeleton form, so that its details can be studied. The features of the smaller Blériot are now too well known to be detailed, and for next season the general lines have not been altered, though many minor changes have been made.

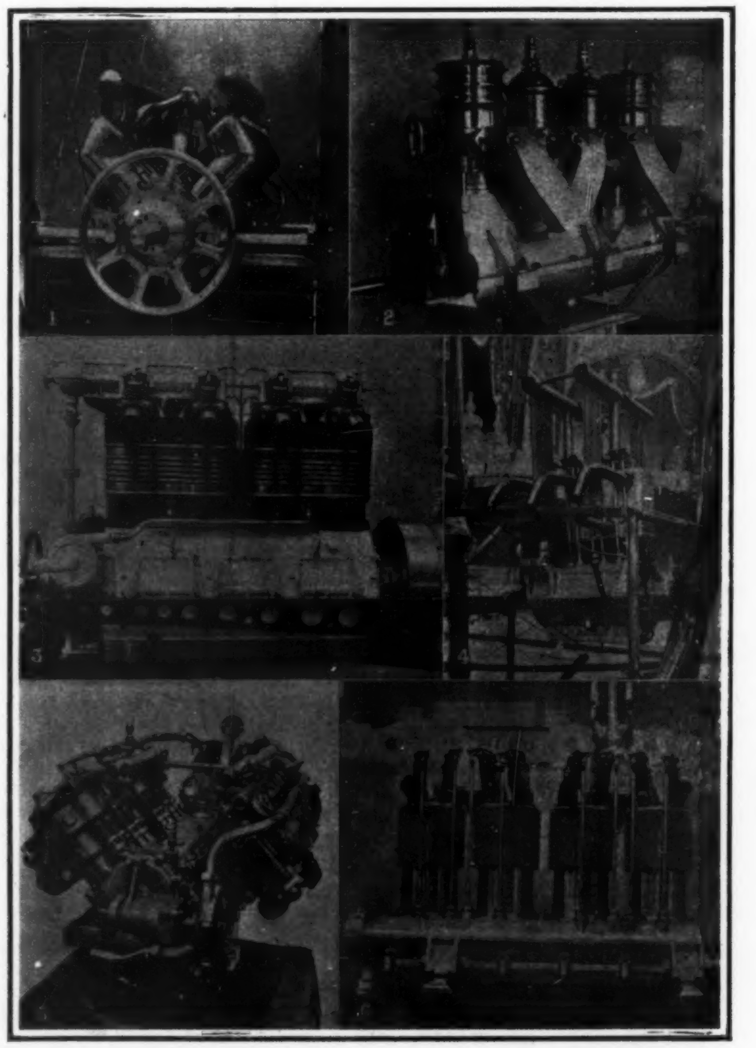
In the small machine the pilot is situated so that he can overlook the main plane, but in the large machine he is underneath it, and the engine drives the propeller through chain-gearing. The control gear is very ingeniously concentrated in a small column fitted with a wheel and various sectors. Noteworthy is the method of protecting the cables from injury by a dome shield at the base of the column. The workmanship is splendid in every respect.

The R.E.P. machine has not done anything very startling this year, and this is remarkable, for the machine is of very good design and has been well tested. The element of luck, no doubt, has affected the issue. The R.E.P. monoplane on view shows very few departures from previous designs. Some changes have been made in the control, and the method of turning the wings about their longitudinal axis is one of the novel features of this machine.



NOVEL MONOPLANES AT THE PARIS AERONAUTICAL SALON.

1. Lioré monoplane with twin screws in front. 2. Gregoire-Gyp monoplane with novel Gregoire motor. 3. The Avia, a new monoplane similar to Santos Dumont's. 4. The Hanriot monoplane with double skids.



AERONAUTIC ENGINES EXHIBITED AT THE PARIS SALON.

1. The English E. N. V. 50 horse-power 8-cylinder motor. 2 The Prini-Berthaud, a new French motor. 3. The 200-horse-power Clement-Bayard airship motor. 4. The Gregoire, a novel French motor with radiator combined. 5. The De Dion airship motor. 6. The 50-horse-power Darracq motor.

Of the new models the Hanriot is one of the most interesting. Its special feature is the arrangement of a pair of skids outside, and parallel with, the supporting wheels. Few of the monoplanes are well provided in this respect, save, of course, the Antoinette with its powerful single skid in front. The Lioré monoplane is noteworthy in that it employs two screws, each driven by chain gearing. A double set of radiators is also provided to the engine. The Gregoire-Gyp is on rather more conventional lines, but the mounting of the engine and radiators is worthy of attention, as being conducive to effective cooling. For controlling the rear rudder a movable back rest is fitted for the aviator, so that by shifting his body he can bring about the desired movements. There are obvious disadvantages to such a method, however.

In the Vendome monoplane the most striking feature is the arched frame for the chassis, which is mounted on two wheels. It presents a strong yet

graceful appearance. It is of interest that on this machine the vertical and horizontal rudders are not freely moved on their axes, but are really feathered. This term "feathering," by the bye, is incorrectly applied to the free moving rudders on other machines. It ought to be restricted to describe a movement similar to that of warping or tensioning surfaces. The Koechlin monoplane is of Swiss design, but has no very novel features about it, which perhaps is an advantage, for it is built on well tried lines. As for the Avin, it is like a sleigh placed under the main plane, and has skids and two large wheels.

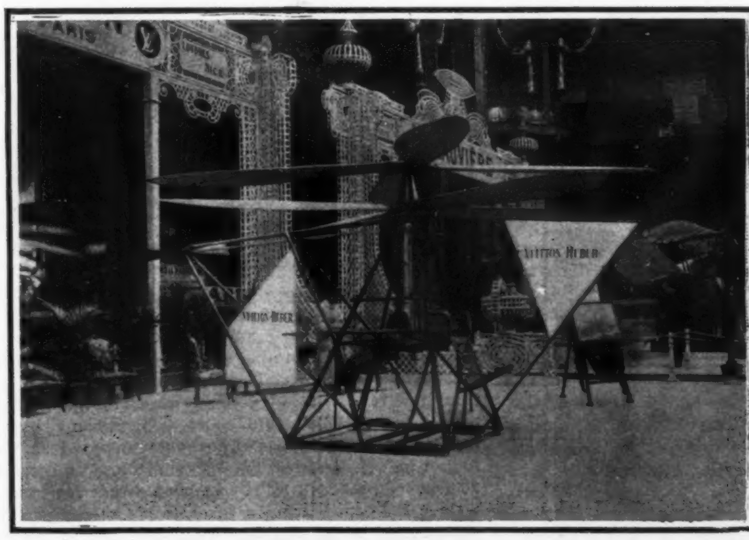
Of the biplanes the most representative display is made by the Wrights. In the gallery one can study the machine of 1903, which in that year flew longer distances than many of the new machines have yet flown, or are likely to fly. On the ground floor the development can be traced in one of the machines used in France this year, and finally one comes to a in the year in London. A neat and simple machine is the Fernandes, which is a blend of Wright and French practice, and is rather smaller than usual. It combines a skid with three wheels.

Out of the ordinary is the machine shown on the Chauvière stand. This has its lower plane upturned so as to join the upper plane at its extremes. The rear plane is set much farther back than the front, so that they barely overlap. A single screw is mounted in front after monoplane fashion. Another novelty is the Salmson, which has a horizontal plane mounted over a deeply arched plane. Two propellers are used, the whole affair being mounted on skids. In the De Dion we have ten planes mounted in two sets of five on V-shaped arms. Four propellers are employed, and a 100-horse-power engine will be used. The planes are short, and are movable about their axes. The good points of the design are not quite obvious.

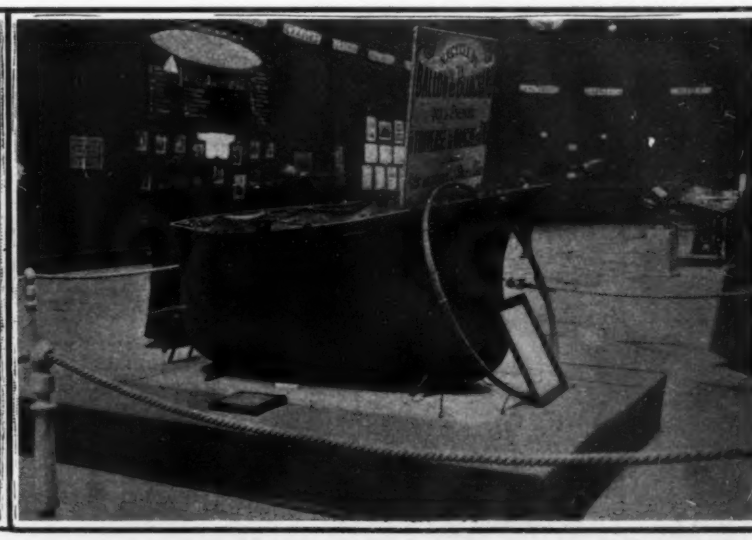
A rebuilt model of the siege balloons of 1870, and probably be found good here, since the airship engine must above all things be a stayer and be economical with fuel.

In the airship engine section the principal exhibits are made by the Wolseley, the Panhard, the Renault, and the Clément-Bayard firms. All are powerful motors staunchly built, and without exception vertical cylinders are employed. The whole engine is shown in some instances mounted ready on its wooden bed, springs being employed to lessen the vibration. There is not much room for radical departures from ordinary practice in these models, but nevertheless there are many evidences of careful attention having been given to their special requirements.

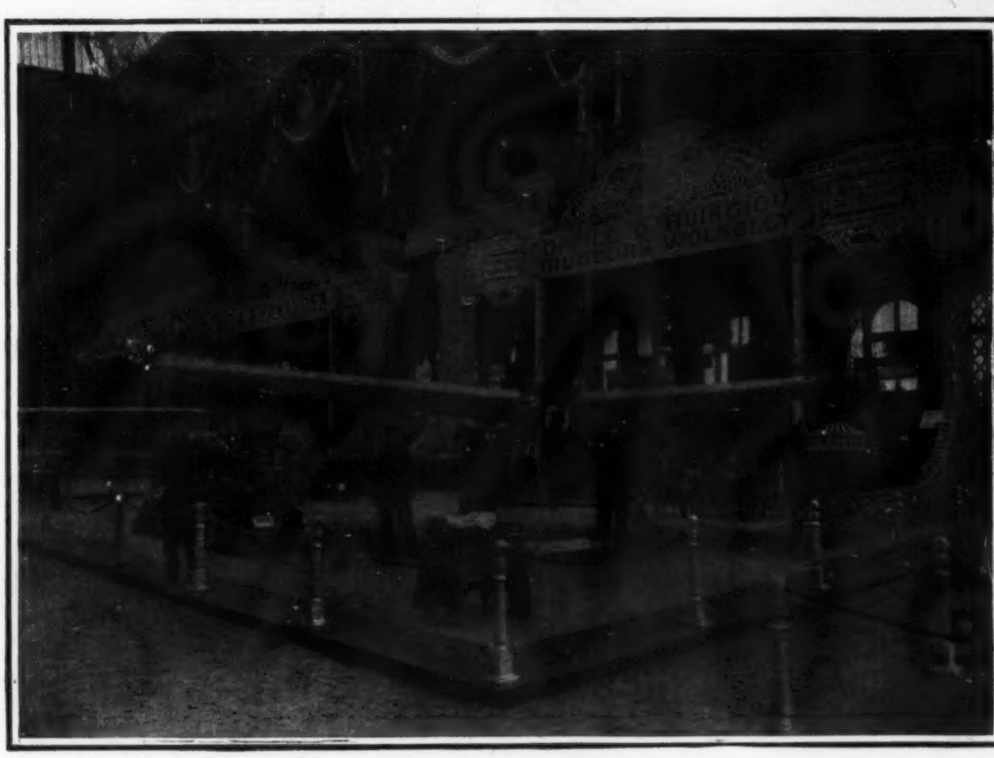
For infinite variety we must turn to the aeroplane engine. Here very difficult and rather more complex problems have to be considered; and, according to the importance placed on each factor, so does the design vary. The craze for extreme lightness, however, is



THE NOVEL HELICOPTER OF VITTON-HUBER.



CAR OF BLANCHARD BALLOON—THE FIRST TO CROSS THE ENGLISH CHANNEL.



THE NEW WOLSELEY MONOPLANE.

THE OLD BALLOON "VOLTA," USED FOR SCIENTIFIC PURPOSES IN 1870.

SOME EXHIBITS AT THE SECOND PARIS AERONAUTICAL SALON.

new machine of the French-built type. This does not differ materially from the previous type, although the workmanship is more careful. If the demeanor of the crowd is any indication, it would seem that the Wright machine is no longer first favorite in France with the public. But then the Parisian is proverbially fickle.

The latest Farman machine shows few changes from the type used so well at Rheims. Its most distinctive feature, apart from the *ailerons* at the rear of the main planes, is the method of combining the skids and wheels. By a simple arrangement the latter are saved from the full force of the impact when landing, and thus are not liable to damage. A very pleasing machine is the new Clément, which was tested just before the show opened. Its planes have rounded edges, there are supplementary planes for balancing placed between the main planes, and the tail is less pronounced than in other French types. No side panels are fitted. The only Voisin shown was the old type as exhibited earlier of a Montgolfier hot-air balloon, a tattered specimen of one of the vessels actually used during the siege of Paris, and good examples of Continental and Michelin balloon fabric make up the other exhibits in the aerostatic section, apart from the dirigibles, of which I have already treated. Attention must also be called to the very good historical section, in which many precious relics of aeronautics are to be seen. A special article would be required to do full justice to this.

Turning to the engines we find a most varied collection, also entailing a long period of study if their features were to be fully brought out. Opinions are yet very divided as to what constitutes the best form of aerial engine. We have first of all to carefully distinguish between the aeroplane motor and the airship motor. The latter is an expensive and specialized type which will only be taken up by a few firms, for not every factory has the resources for turning out engines of some 200 horse-power. Marine practice will dying out, and indeed it is now well known that there is no great need for high-powered engines to give the required lifting effect if other things are all right. It shows mere brute force when a very big motor has to be fitted in order to get a machine capable of carrying one or two persons in the air.

The craze for very high piston speed is also past its zenith, and a more determined effort is now being made to give medium-speed engines, which will run without trouble for longer periods of time. Economy of fuel has not been given much attention in many cases yet, and some of the little featherweight engines are exceedingly extravagant in this respect. The subject of lubrication is very difficult, and by no means settled, and the matter of cooling has led to many differences of opinion, which are borne out by highly distinctive designs.

Some comment has been made on the fact that the two most notable performances of the year have been

accomplished with engines which, not so long ago, were dubbed "freaks" by many people. Thus Farman used the Gnome revolving motor in his longest flight, and Bleriot adopted the three-cylinder Anzani when flying the Channel. But it must be borne in mind that the Wrights, for example, employ a simple type of four-cylinder vertical engine, and very many good feats have been done with engines which do not depart radically from the orthodox type.

This latter fact does not destroy the contention, however, that the best type of aeroplane engine will differ widely from the car engine. Indeed, everything points to a number of special types being evolved. The new Darracq engine has revealed the possibilities of the two-cylinder horizontal engine, and the makers also build a very fine vertical engine. Several firms adopt star-shapes, in which a number of cylinders are grouped radially around a central body. In the Gnome the whole engine rotates and thus cools itself automatically. There is also a model of the Beck rotary motor, the pistons working within a ring in a most ingenious fashion.

A very good show of the E.N.V. engines is made in various types, and the Gregoire firm have a neat little motor with very good cooling facilities. Renaults have taken up the new branch very thoroughly, and one of the novelties is their motor cooled by an inclosed fan blast.

Fiats have a beautiful little V-shape engine, in which weight has been well saved. Of the Antoinette there are many specimens, ranging up to the great sixteen-cylinder 100-horse-power engine, all being of the V type. De Dions have some very well thought out models also, and Mors attract much attention by their new engine. The Prini-Berthaud is another notable type, while last, but not least, mention must be made of the Green vertical motor, which is simple and clean in its lines as compared with many of the Continental models.

The aviator cannot grumble about lack of variety, and provided he can get trials of the various types he should be able to arrive at a far better selection than a year ago. Indeed, the engine makers may be said to have done their part of the work well. It remains for the aviator to show which engines are really suited for the rough and ready work in the air.—The Car.

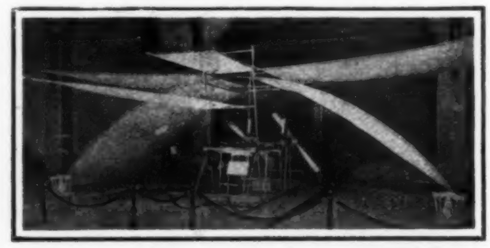
THE PARIS AVIATION EXHIBITION.—I.*

The exhibition of flying-machines which opened at Paris, on Saturday, the 25th of September, marks a distinct stage in the progress of aerial navigation. While there are examples of the dirigible balloon on view, the exhibition is devoted almost exclusively to aeroplanes, motors for them, and accessories. Those who have followed the developments of the aeroplane will be aware that during the last twelve months an enormous amount of progress has been made. Not only have the aeroplanes of the older makes been improved, so that they will now fly a much greater distance than was the case a year ago, but new types have been produced which have made excellent flights, so that now there are quite a considerable number of these machines in existence which, under suitable circumstances, can fly for an hour or two with fair certainty.

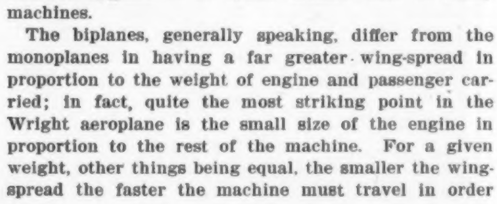
It is no doubt easy to over-estimate the practical importance of these flights, the large majority of which have, up to the present, been made under somewhat artificial conditions, on specially selected grounds, and in favorable weather. Even under these conditions flying-machines have shown a want of reliability which would not be tolerated for an instant in any other class of machinery. A great deal of this want of reliability is due to the engines, which in some cases are at present too light, or too complicated, to perform satisfactorily. It will be recollected that on both the occasions when Mr. Latham tried to fly the Channel he failed through his engine stopping, and it is possible that the fact that Bleriot used a comparatively simple motor, with only three cylinders, contributed a great deal to his success. Those who are acquainted with the history of the automobile will, however, be aware that a few years ago it was as imperfect as the aeroplane is now, and it is quite possible that in the future the latter may progress in lightness, power, and reliability in the same way as the motor-car has done, and in this case it will become a very important factor indeed, especially for war purposes.

Practically the whole of the machines shown are of the monoplane or the biplane type, the former generally following the well-known lines of the Bleriot and "Antoinette," and the latter those of the Wright and Voisin. The biplane undoubtedly held the lead for a long time; but the recent flights of Bleriot, Latham, and Santos Dumont have demonstrated that the monoplane has great possibilities. Among the monoplanes, the one in which Bleriot flew across the Channel naturally excites the greatest interest, and the point which at once strikes one is its small size. In this, however, it is completely eclipsed by Santos Dumont's "Demoiselle" (dragonfly), which has the distinction of being by far the smallest, as well as the fastest and cheapest aeroplane, yet made. It measures 20 feet long over all by 17 feet wide across the wings, weighs 230 pounds, can be taken to pieces and packed comfortably on an ordinary motor-car, and it is said that it can be built at a profit for 200*l*. The "Antoinette" is larger than the Blériot, but in many ways takes the eye more than any other machine in the show. The boat-shaped body looks simple, substantial, and light, as compared with the girder-frames, trussed with large numbers of steel wires in some machines, and the attachments of the wings appear simple and substantial. The whole proportions and appearance are more bird-like than those of any other machine, which naturally prepossesses one in its favor; and though, of course, its appearance is no guarantee that it will perform best, it has given excellent results in practice. The aviator sits in the body in much the same position as he would occupy in a boat, and his comfort appears to be better studied than in many machines.

GENERAL VIEW OF ONE END OF THE MAIN HALL.



THE SALMSON BIPLANE WITH ARCHED LOWER SURFACE.



A NOVEL BIPLANE AT THE CHAUVIERE STAND.

SOME EXHIBITS AT THE SECOND PARIS AERONAUTICAL SALON.

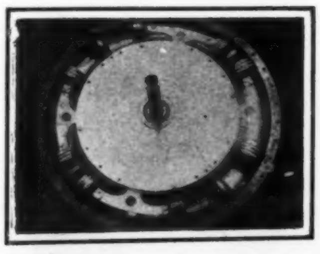
The biplanes, generally speaking, differ from the monoplanes in having a far greater wing-spread in proportion to the weight of engine and passenger carried; in fact, quite the most striking point in the Wright aeroplane is the small size of the engine in proportion to the rest of the machine. For a given weight, other things being equal, the smaller the wing-spread the faster the machine must travel in order to be able to lift itself from the ground, and the more power must be provided; accordingly, we find that the "Demoiselle" has a very large engine indeed in proportion to its weight.

The question of what wing-spread and speed will be found best must remain for some time a matter of experiment. The most important point is, no doubt, what arrangement will give the longest flight with the fuel which can be carried, for at present the limit is determined by the supply of fuel. As the wing-spread is increased the lifting power per horse-power is also increased, but increasing the wing-spread in itself makes the machine both heavier and slower. Structurally at first sight the biplane seems much superior, as the two planes only need wooden struts and steel wire tie-rods to make the whole a very strong trussed girder. It is, however, possible that these struts and wires offer a considerable amount of resistance to the air, and the dependence of the whole structure on such a large number of very thin

* Engineering.

wires may also be an objection, as they are subject to vibration, which may deteriorate the metal. The structure of the monoplane, on the other hand, is much simpler, and though it may not be theoretically so light, it is possible that it may prove the better in practice. The wings usually consist of a fairly substantial backbone of wood or steel tube, with a simple truss below and above, constructed of two or four wires and the necessary struts. These wires being few in number, are far more substantial than the innumerable cross-wires of the biplane.

The motions required to control the aeroplane are usually three. There is a rudder on a vertical axis to steer in the usual way, and a rudder on a horizontal axis to control the elevation. In addition to this there is usually some sort of control of the inclination of the aeroplane sideways, this being necessary to prevent its turning on its side going round corners. This control is effected either (1) by pulling down the after part of a wing on one side, so as to make that side lift more than the other; (2) by twisting the whole of the main tube which carries the wing; or (3) by having small supplementary planes at the ends of the wings, the angle of which can be altered. The first-named plan seems much the most common. In many cases one handle controls two of these movements, some of the different arrangements being as follows:



SECTION OF BECK ROTARY MOTOR.

Antoinette: Steering by the feet; elevation and wings controlled by wheels on the right and left hand respectively.

Wright: Steering and wings controlled by one hand-lever, elevation by the other.

Bleriot: Steering by the feet; one lever controls elevation and wings.

Lioré: Steering by feet; wings and elevation controlled by separate levers.

Koechlin: Steering and elevation controlled by wheel; wings by the back of the seat.

Voisin: Steering and elevation controlled by wheel.

Clement: Steering and elevation controlled by wheel; separate lever for wings.

Farman: Steering with the feet; one lever for elevation and wing-tips.

Santos Dumont: Steering and elevation controlled by separate hand-levers; wings by lever attached to aviator's back.

When one lever controls two movements, it is pushed backward and forward for one, and from side to side for the other. Where a wheel is used for steering and elevation, it is turned to steer, and pushed forward and backward for elevation.

In all examples, except the Wright machine, there is a balancing-tail behind to make the machine more stable longitudinally, this being a matter which in this make depends entirely on hand control.

The Voisin machine differs from the other biplanes in having several vertical partitions between the two planes, both of the main lifting planes, and also those in the balancing-tail, and in having no arrangement for twisting the wings to maintain lateral stability. In the majority of cases the tail is attached to the main plane by a trussed girder, of which the top and bottom members are of wood as well as the struts, while the tie-rods are of wire, the construction being exactly the same as that of the trussed girder of a biplane, and appearing to be open to the same objections. In the monoplanes there are, however, examples of wooden box girders and of steel tube attachments. Considering how very light, in proportion to its strength, a racing sculling-boat is, it seems quite possible that a box girder of similar construction might be the most satisfactory, as, even if the trussed girder saved a few pounds weight, it is probable that the extra air resistance would involve more weight being required for the motor and fuel. In the majority of cases a single propeller is used, placed direct on the crankshaft, and driven at the engine speed; but in some cases the propeller is geared down, often by a chain, and Wright uses two propellers, one driven by a direct chain and the other by a crossed chain. Chains of the length required appear to be rather a doubtful expedient when run at such high revolutions, and the method adopted in one of the Renault engines, of coupling the propeller to the camshaft, which is driven by suitable gearing, appears much better, if it be desired to reduce the revolutions.

The Bleriot aeroplane, as exhibited by M. Bleriot, is illustrated herewith. It will be seen that the engine is mounted in the extreme front of the frame, with the direct-coupled propeller in front of it. The aviator sits well behind this in the inside of the lattice girder forming the main frame, while the two wings are carried on a strong cross-piece, which is stayed to the under-carriage with two main shrouds in front, and two wires behind for warping the wings. At the back of the main frame is the tail containing the horizontal and vertical rudders.

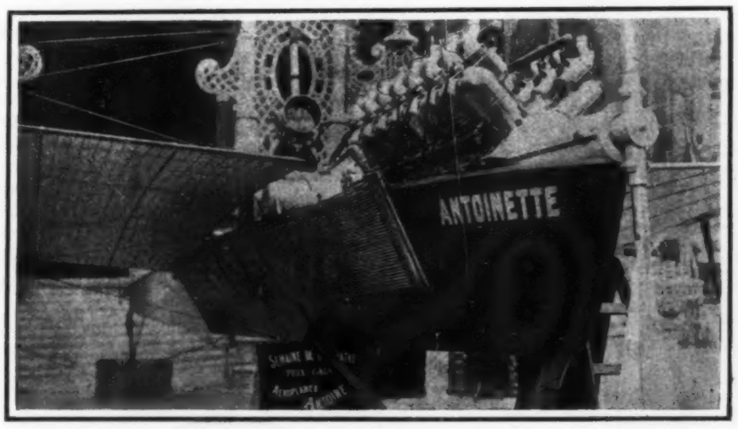
In the "Antoinette" aeroplane, the general arrangement is very much the same as in the Bleriot, with the exception that the main frame is entirely cased in. It is also not constructed with wire tie-rods, but is entirely made of wood; and the forward part is planked with thin mahogany like a sculling-boat, the after part being covered with thin oiled silk. The tail plane, as is also that in the "Demoiselle," is flat, whereas in the Blériot and most others it is curved like the main wings. The flat plane is no doubt both the cheapest and lightest to make, and possibly offers less air resistance. The main wings of the "Antoinette" appear to have less curvature than in most other makes. The under-carriage is of very substantial construction, and yet should not offer great air resistance, being composed of few parts. The aviator sits well back from the bows, just behind the main wings, in fact, and has a really comfortable seat—a matter probably of great importance.

The workmanship in the majority of the aeroplanes exhibited appeared to be excellent, so much so that it is impossible to point out one as being distinctly superior in this respect.

An exhibit of great interest is the Wright aeroplane, in which the first real flights were made at the end of 1903, and it is remarkable how very little different it is from the latest Wright models; in fact, the older machine is hardly distinguishable, except for its weather-worn appearance. Probably a great deal of the advance made in the six years has been due to the experience of the men rather than to essential modifications in the machine.

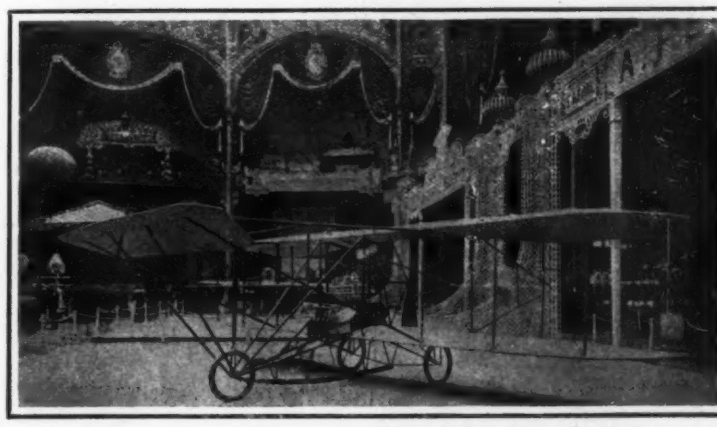
(To be continued.)

THE BLERIOT NO. 12 MONOPLANE WITH CHAIN-DRIVEN PROPELLER.



THE BOAT-LIKE BOW OF THE 100-HORSE-POWER ANTOINETTE MONOPLANE.

The engine has 16 cylinders and is of the V-type. The condenser is seen on the side of the body.



THE FERNANDEZ BIPLANE WHICH RESEMBLES THE CURTISS.

This machine has merely a single-surface horizontal rudder in front.

SOME EXHIBITS AT THE SECOND PARIS AERONAUTICAL SALON.

ELECTRO STEEL.

Although, remarks Engineering, it would be premature to attempt a prophecy as to the revolutions the electric methods are likely to cause in steel manufacture, people are fairly well agreed that they are likely to be exceedingly important and that the new methods more especially may influence the respective values of the different kinds of iron ore. This latter view has caused some uneasiness in certain quarters, among others, in Sweden, where recent announcements as to the result of electric treatment of Luxemburg ore have attracted considerable attention.

The newly-started electric furnace at the Eichen Hüttenwerke, at Dommeldingen, gives, says a German paper, an electro steel of excellent quality, fully equal to the very best Swedish, which, it is urged, proves that the value of the Luxemburg minette ore has been raised to the same level as the famous Swedish iron ore. It is further claimed that the introduction of the Röchling-Rodenhauser induction furnace will prove of incalculable importance to the Luxemburg-Lorraine iron industry, which has at its disposal immense iron-ore deposits favorably located as to transport. A complete revolution of the entire Rhenish-Westphalian iron industry is foreshadowed, and Luxemburg, it is stated, will more and more become the center of this industry.

The above statement, interesting as it may be, is discredited in Sweden, where the Röchling-Rodenhauser furnace is well known, being a kind of modification of, or a combination of, two Kjellin furnaces. This arrangement appears to entail a material saving of current and labor; but as far as is known in Sweden, there has, so far, only been a question of producing expensive qualities of steel in comparatively small quantities, and the raw material has in any case been iron straight from the blast-furnace. The alleged new process for direct handling minette ore is, in the meantime, discredited in Sweden. It is, however, admitted that the new process is likely to rid the Luxemburg ore of some of its impurities, and to produce from this somewhat inferior material a steel of quality capable of vying with the Swedish. This points to the fact that the Swedish steel is about to lose its peculiar position, and that Sweden for the future will have to go in more for quantity than for quality.

APPROPRIATIONS FOR THE PANAMA CANAL.

The Isthmian Canal Commission has submitted to the Secretary of War an estimate of appropriations aggregating $48,063,524 for work on the Panama canal during the fiscal year beginning July 1st, 1910. Of the amount, $15,504,036 is for skilled and unskilled labor and $20,218,983 is for materials and supplies used in construction work. The total appropriations made by Congress up to this time on account of the canal are $270,070,467. Colonel Goethals, chairman and the chief engineer of the commission, is stated to have declared it to be his opinion that the great waterway will be completed by January 1st, 1915, and has estimated the total cost at $375,000,000, including the cost of sanitation and civil government and the $50,000,000 purchase price. The unusually large amount asked for the new fiscal year is considered to be due to the fact that work on the waterway has entered a more advanced stage.

PHOTOGRAPHY IN THE SERVICE OF THE LAW.

THE SCIENTIFIC DETECTION OF CRIME.

BY DR. O. MEZGER.

THE value of photography in the identification of persons and of finger prints is generally known. There are many other ways in which important evidence can be obtained by means of photography. In a case of poisoning by arsenic, strychnine or any other substance that can be recovered from the body of the victim and isolated, the expert can lay before the court the result of his investigation in visible and tangible form. This is impossible in cases of poisoning by hydrocyanic acid or carbon monoxide, and in

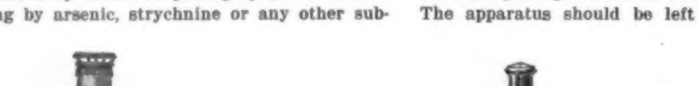


FIG. 1.—MICROPHOTOGRAPHIC CAMERA.

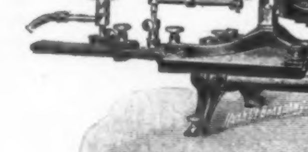


FIG. 2.—A BILL IN WHICH A 5 HAS BEEN CHANGED TO A 6.

many other criminal and civil trials. In such cases photography may be employed with advantage to make instantaneous and permanent records of the observations made by the experts in the course of their in-

FIG. 3.—A RECEIPT IN WHICH THE AMOUNT HAS BEEN RAISED FROM 400 TO 1,400.

vestigations. It is obvious that photographs made for this purpose should not be retouched.

The microphotographic camera, vertical or horizontal, is required in many cases. The instrument should be of solid construction and should be used in a place

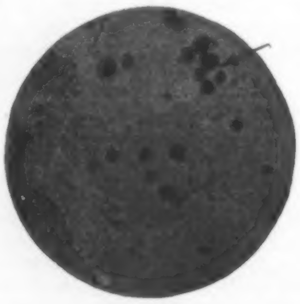


FIG. 4.—STARCH GRAINS IN SAUSAGE.

absolutely free from vibration. Either daylight or artificial illumination may be used. The writer has found the Auer (Welsbach) incandescent gas burner very satisfactory. The Leitz universal microphotographic camera, a convenient and excellent apparatus, can be used in either the horizontal or the vertical position. It is shown in the horizontal position in Fig. 1. In this position it can be used for enlargements requiring a camera more than 10 inches long. The apparatus should be left undisturbed until the plate has been developed so that, in case of failure, a second negative can be made under the same conditions. When the Auer light is used the texture of the mantle may appear in the photograph, but this defect is easily remedied by the interposition of a ground glass screen. Ray filters of colored glass or liquids

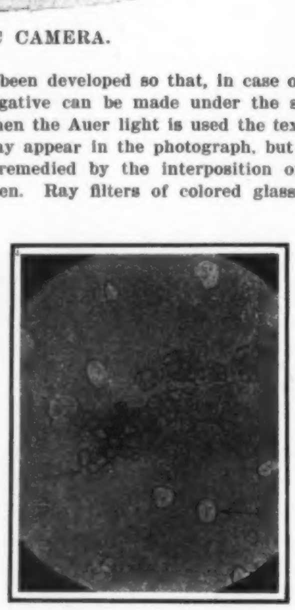


FIG. 5.—PEPPER ADULTERATED WITH BARLEY MEAL.

are often useful for increasing contrast, and it is advisable to use orthochromatic plates. For the positive prints, glossy papers which show every detail of the negative are decidedly preferable to papers with a dull surface.

In the investigation of forged and altered checks and other writing it is often important to preserve a record of the appearance presented by the document

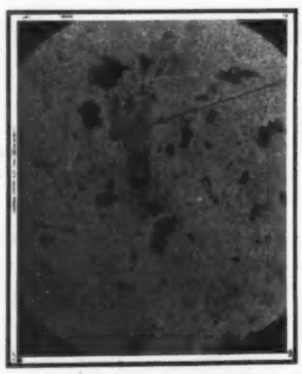


FIG. 6.—CINNAMON ADULTERATED WITH SAWDUST.

before it has been treated with chemicals for the purpose of determining the character of the ink. The document may be photographed without enlargement, but it is generally advisable to make an enlarged photograph, in which the forgery or alteration is often more easily detected than in the original. Single letters and figures may be photographed either by reflected or by transmitted light. The latter is frequently useful for detecting erasures.

The advantages of the photographic method are illustrated by Figs. 2 and 3, taken from actual practice. Fig. 2 is an enlarged photograph, taken by reflected light, of a bill in which the amount 58.50 (marks) was changed to 68.50. Fig. 3 is a greatly

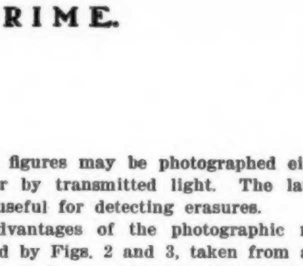


FIG. 7.—FIBERS OF CHEWED PAPER.

magnified photograph of a receipt in which the amount, 400, which follows the date 1905, was raised to 1400. The contrast between the tremulous character of the inserted and the steadiness of the other figures is made more conspicuous by the enlargement.

Microphotographs of adulterated articles of food are illustrated in Figs. 4, 5, and 6. Fig. 4 shows a section of a sausage adulterated with flour, in which the starch grains have been stained blue by a solution of iodine and thus made more conspicuous. They are indicated by the arrow. Fig. 5 shows pepper adulterated with barley meal. The grains of pepper are indicated by the arrow at the left, the larger starch grains by the arrow at the right. Fig. 6 shows cinnamon adulterated with sawdust, which is indicated by the long arrow.

FIG. 8.—FIBERS OF WURTEMBERG BONDS.

An interesting case is illustrated by Figs. 7, 8, and 9. Crumpled fragments of Wurtemberg government bonds were found in a jail yard, together with pieces of paper which had evidently been chewed. A little of the chewed paper was also found adhering to the window grating of a cell occupied by a man who had been arrested on suspicion of robbery and murder, and this was the only evidence connecting the paper with the prisoner. The chewed mass was found to consist of pure linen paper of the sort on which all Wurtemberg bonds are printed. Microphotographs of the chewed paper (Fig. 7) and of a Wurtemberg bond (Fig. 8) showed perfect identity in the character of the fiber which, on the other hand, differed strikingly from that of other papers which were examined in the course of the investigation. The structure of a sample of newspaper, for example, is shown in Fig. 9.

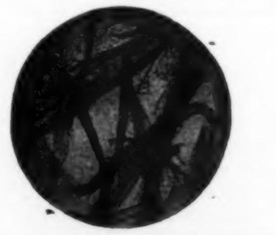


FIG. 9.—FIBERS OF NEWSPAPER.

These few examples may serve to give an idea of the important service which photography, in the hands of experts, is able to render to the cause of justice.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Umschau.

ROSES FOR WINTER.*

COLD WEATHER GARDENING.

ONE of the sadnesses of the summer garden is the fact that its beauties last for such a short while. Too soon the winter comes, when we may search in vain for the gay blossoms which held up their heads so brightly to the warmer sun. But with a little care it is possible to preserve at any rate one of the most valued of our flowers, and in this way retain some of the loveliness of the border for the dull months. In this article a special method of treatment is indicated whereby roses may be dried, and, when required, brought back to a fair resemblance of their original beauty.

The best time to set about this method of preserving roses is in the fall, when, owing to the cool weather, the flowers develop more slowly and are thus in every way better. Almost any of the larger kinds will answer the purpose well, and the blossoms should be gathered when in bud, just after the petals are mature, and yet before they have started to unroll. Care should be taken to see that the buds are quite dry, and if they should have any moisture on them it is well to spread them out for a day or so in order that the dampness may pass away. As many roses as possible should be secured in order to make allowance for a certain number of failures; it is not to be expected that all will be entirely successful.

With all the buds to be preserved gathered together, the next step in the treatment may be taken up. Procure the lid of a tin can and around this twist a piece of wire in such a way that it can be held like a small pan. Now into the receptacle place a few lumps of candle wax; then holding the lid over a lighted candle, take each rose bud and dip the end of the stalk in the melted wax, repeating the process several times so that a small lump of the substance is formed on the end of the stem. Next, very carefully tie a small piece of silk twine around each of the buds—just tightly enough to keep in place without in any way injuring the petals.

The next thing required will be one or more tin boxes. It is not recommended that these should be very large, those answering the purpose perhaps best of all being the small long-shaped biscuit boxes. The lids of these, as a rule, fit exceptionally well, and this is rather an important feature. Take some tissue paper and cut this into pieces each one of a size to accommodate a single rose bud. Wrap the flower head of each specimen in the paper, tying it securely at either end with silk. It may be as well here, perhaps, to insist again on the importance of each rose being absolutely free from any surface moisture, one example in a damp condition placed in a box being sufficient to spoil the whole of the contents. When the roses are wrapped up they may be packed away in the boxes, each of which has been previously lined with wadding. The buds may be put in fairly closely, as long as they are not really crushed when the lid is put on. In order to make the box doubly air tight it is well to paste thin strips of paper around the joints of the lid. All the boxes as they are loaded with buds should be placed in a closet; it is important that the temperature should be well maintained, although the boxes must not be put in a really hot place.

The roses may now be left just as they are for a period of two or three months; longer than this it is scarcely advisable to leave the buds. When it is decided to revive the sleeping flowers the boxes may be opened and the buds taken out one by one. Extreme care must now be exercised in the handling of the specimens, as they will be in a very brittle state, and it is very easy to damage them in this condition. Gently unwrap each bud, and with a small pair of scissors cut away the silken bands which encircle the petals. Next take a basin full of hot—not boiling—water. Now take each bud and with a stout pair of scissors make a clean cut through the stalk a fraction of an inch above the sealed end. As soon as this has been carried out the stalk should be immediately immersed in the basin of hot water, each specimen being allowed to remain in the liquid for five minutes. Now prepare a large bowl full of clean fresh water into which has been cast a small handful of common salt. Into this all the roses may be placed as soon as they have been treated with the hot water, care being taken to see that only the stalks are in the fluid. Now convey the whole thing to a perfectly dark and rather warm cupboard, where the awakening flower should be allowed to stay for several hours. At the end of this time, if the experiment has been carried through on the proper lines, it will be observed that the roses are beginning to take on much of their former loveliness, and in a short while they will develop into much of their original beauty.

Of course, a proportion are bound to be failures, no matter how carefully the roses may have been selected in the first instance. Still with moderate success the worker will feel amply repaid for any trouble taken on account of the value which roses assume in the depths of winter. The treatment might be employed at any time of the year, when roses were available for the purpose.

Like many household arts this simple experiment should not be undertaken without a very ample preparedness for failure. I have already pointed this out more than once, and while I do not wish to discourage those who may be interested enough in this process to undertake it, it is but fair that a further word of caution should be added.

One should not, however, be altogether deterred by the possibility of failure from making the attempt. The process is simple enough, and calls for no complexity of apparatus. Nor, indeed, need one go beyond the resources of the ordinary household for the necessary materials. This in itself is one of the charms of the experiment. It is something every one may do and do easily and quite without expense. Moreover, if but a few of the roses survive the period of repose and experimentation, a few only will yield sufficient compensation, not only through the novelty of their unusual blooming, but through the sense of satisfaction that one will feel that so simple and so beautiful an experiment should have yielded some result.

Perhaps it is a difficult thing to have too many roses

SEALING THE BUD STEMS WITH LIQUID WAX.

WRAP EACH BUD UP IN THIN PAPER.

PASTING UP THE AIR-TIGHT TIN BOX.

TAKING THE BUDS OUT IN WINTER.

* From American Homes and Gardens. Published by Munn & Co., Inc.

in summer; one fairly longs and yearns for the blooming time to hasten, once it seems about to arrive. But one cannot have this royal flower in the winter season without great expense, and then not always in a satisfactory way. The plan here outlined offers delightful opportunities of rose-enjoyment at a time of year when roses are not only scarce, but are positively unknown in the ordinary house. And they will be real roses too, but strangely artificial ones that are sometimes offered to the enjoyment of the rose lover, who, however, knows but the real flower, and can have no patience with the most skillful imitation.

INTELLIGENCE ON MARS OR VENUS.*

THE EVIDENCE PRO AND CON.

BY N. W. MUMFORD.

The study of the possibility of reasoning existence on other worlds is of perennial interest, but intelligent speculation on the subject must be confined to the solar system, on account of the immensity of the void existing between that system and any other. Study of the habitability of the eight known major planets leads at once to the elimination of six of them. The habitability of the earth is a matter of constant observation; that of Mercury may be negatived on account of extreme solar proximity and lack of atmosphere, and of the four outer planets Jupiter, Saturn, Uranus, and Neptune, their remoteness from the central energy, as well as other conditions not discussed herein, may well remove them from the field of consideration. Observation upon the four has yielded negative rather than positive results in numerous ways, so that with the exception of Jupiter, it cannot be certainly stated that any extensive parts of their actual surfaces have been seen. So far is this true, that the times of rotation of Uranus and Neptune remain to be determined, although some recent observations have assigned to their rotation periods 10.1 hours and 12.86 hours respectively.

The two solar satellites, Venus and Mars, nearest neighbors to the earth, with the exception of the moon and the minor planet Eros on an occasional opposition, are left for discussion; and in this it is intended that the assumption of the possibility of life in some form shall be granted, having only in mind the question as to the adaptability of either or both of the planets to the support of that form of life that is called intelligent or reasoning, though of course not necessarily, in physical aspect, resembling man.

Literature upon the appearance and characteristics of the two planets is very plentiful, but is far from evenly distributed. The mass of writings whose subject is the smaller and outer planet is much in excess of all that has ever been written upon Venus and the problematical existence of the Hesperians. This literary favoritism to Mars may be properly attributed to the greater ease of observation of Mars, and the larger rewards for attention given him. The difficulty with which Venus can be viewed, and the little information that she returns for all the astronomer's labor, has kept speculation upon Venus within quite narrow limits though in several important particulars she more nearly resembles the earth than does any other known heavenly body.

In diameter Venus is about 100 miles less than the earth, which is reckoned at 7,926 miles. This resemblance is close, strikingly so; there is no member of the solar system that in this respect at all approaches these two, according to terrestrial standards. The outer major planets are giant globes, measuring from four to ten times the diameter of the earth. Mercury is about 3,000 miles through, and the moon a quarter of the earth's axial measurement. Mars has a trifle more than half the apparent measure of the earth and Venus, or 4,210 miles.

The identity in size between the earth and Venus is followed by another similarity of equal importance, in the study of habitability from the human standpoint; namely, the correspondence in density between the two, which is practically the same. On the other hand, the density of Mars appears to be about seven-tenths that of the earth. Likewise the masses of the planets are as 1 for the earth, 0.8 for Venus, and about 0.11 for Mars, hence would follow a wide disparity between the gravitational force exerted on the surfaces of the pair, and that on the outer planet. But this disparity is modified, for the fact that gravity varies with the inverse square of the distance, acts as a counterpoise in the case of Mars for his inferior mass. Taking the radial measurements, objects upon the surface of Mars lie only about 2,000 miles from his center of attraction, whereas that distance is about doubled for Venus and the earth. The force of gravity at the earth's surface reckoned as 1 is for Venus nearly the same, and for Mars about 0.38; so that a man weighing 150 pounds, transported to Mars would find his weight reduced to about fifty-seven pounds.

The chief interest in these comparisons attaches to their resultant effects on the volume and mass of the planets' atmospheres. The study of the air surrounding the two neighboring planets gives the following results: taking the volume of the earth's atmosphere as one, that of Venus is approximately 0.92, and that of Mars about 0.22; and in regard to mass, the earth's being reckoned at one, the mass of Martian atmosphere seems to be not over 0.10, and that of Venus not much more than the earth's. Observation of Venus indicates a dense atmosphere, but its true density is unknown. It is interesting to note the theoretical height of the barometer under such varied conditions. Normally at sea level, the terrestrial barometer records thirty inches, while on Mars its height would be about 2.5 inches, and on Venus approximately twenty-seven inches.

The conclusion to be drawn from the study of atmospheric conditions, seems to be decidedly more favorable to the presence of life, as known on earth, upon Venus than upon Mars. Further light may be thrown upon an examination of the subject, by a consideration of the kinetic theory of gases as related to atmospheric air.

The molecules of air are constantly in motion at prodigious activities, and are sustained with, or bound to, the governing body by its force of gravity. Nevertheless there are certain constituents of the earth's atmosphere that are continually flying off, or escaping into space, such as hydrogen, free hydrogen forming no appreciable part of the air. Upon experiment it is found that atmospheric molecules are continually controlled and held in sway, up to a certain limit of activity, beyond which limit of speed, which is called the velocity of escape, the molecules will tend to fly off and disappear from terrestrial constraint. The velocity of escape for molecules of the earth's atmosphere is found to be 6.95 miles per second, a speed so high that it is only in the case of the very lightest gases that terrestrial atmosphere is drained of any of its constituents. The velocity of escape upon Venus is almost as high, namely, 6.37 miles per second, or quite sufficient to withhold water vapor, the prime essential with atmospheric air. On the other hand, the velocity of escape upon Mars is computed at 3.13 miles per second, a speed high enough to retain carbonic acid gas, and parts of the terrestrial ingredients, but theoretically very little of the vapor of water. Telescopic examination of Mars seems to point to an almost entire absence of clouds, in an atmosphere exceedingly thin and clear. Some doubtful objects noted above the surface may properly be attributed to sand storms. On the other hand, the consensus of opinion on the question of water vapor on Venus is largely in favor of a very moist atmosphere, heavily laden with clouds. But on this point there are the Flagstaff observations, which deny the existence of clouds.

The Flagstaff observations command attention, and introduce a view radically different from the foregoing as to the possibility of life on Venus. A publication on the subject from the Lowell Observatory states that the first essential for animate existence is the alternation of day and night. Observation at Flagstaff fixes the rotation of Venus as synchronous with her revolution, causing the planet to turn forever the same face to the sun, as does the moon to the earth. The result is one hemisphere of excessive oven-like heat, while the opposite hemisphere lies under perpetual glacial ice. The atmosphere is described as yellowish and free from clouds or apparent moisture. The surface shows distinct markings, strangely enough resembling those originally drawn by Schiaparelli from Mars, similar markings to which the Flagstaff observers also depict as present on Mercury. The synchronous rotation of Venus coincides with the distinguished Italian's observations.

In spite of the seeming period hereby put to the discussion, the thoughtful observer will still detect the possibility of animate existence upon Venus. It may be questioned whether the prime essential to life is axial rotation. If the choice of evils were allowed the human race, it would no doubt agree to dispense with rotation, rather than with eighty per cent of the earth's atmosphere and water and conform to Martian conditions.

Here one may pause on a point of speculative interest. Will the dissolution of animate life on earth, unnumbered ages hence, follow the slow development said to be presented by Mars, or pass through those dying phases of which Venus is said to show an example? Will tidal friction at the last put a stop to the sure and steady clockwork of rotation, and reduce one hemisphere to a desert, jeopardizing or annihilating all existence, or will that phase arrive long after the earth has reached and passed through the Martian stage, when by absorption into the earth's crust and evaporation, and by leakage into space, it has lost all moisture and atmosphere? The struggle for existence may be acute, indeed, upon Mars, and may be equally so upon Venus for fundamentally different reasons. Will humanity at the last take part in a struggle of both kinds?

Upon considering the factors bearing upon both questions, it seems likely that the present phase of Venus more nearly resembles the earth's ultimate condition than the observed state of things upon Mars. The slowing down and eventual stoppage of terrestrial rotation may be incalculably tedious and distant, but the period of time to elapse for the disappearance of air and water is infinitely long and must remain so, while the earth retains anything like its present mass, and the law of gravity continues unimpaired.

The difficulty of observation of Venus has already been referred to. The work was carried on at Flagstaff principally in the daytime, night observations being hindered by earth vapors, or by proximity to the horizon, since, at her greatest elongation, at sunset Venus is only forty-seven degrees above the horizon, a little more than half-way to the zenith.

In refutation of the observed absence of clouds above noted, their presence on Venus may be inferred from the very high albedo, or ratio of the light reflected from the planet to the total sunlight falling upon her. This ratio is much higher for Venus than for any other planet, a fact attributable possibly to the presence of masses of cumulus clouds.

The remaining known characteristics of the planets may be briefly stated. The average distance of Venus from the sun is nearly 0.7 that of the earth, while Mars's distance is 1.5 times that of the earth. In regard to insolation or direct rays of the sun's light and heat received by the three bodies, if unity represents the earth's amount, Venus will receive 1.9 as much, and Mars 0.43 of the same amount. Theoretically the temperature of black bodies at the known distances from the sun will vary as 176, 86, and —22 deg. F. The implication is not that such temperatures actually obtain, but experience shows that the figure set for the earth is not very wide of the reality. The apparent size of the sun's disk from the earth is a little over half a degree in diameter, seen from Venus he appears thirty-eight minutes in diameter, and from Mars twenty-one minutes in extreme width. The absence of a vapor blanket is consistent with the drought conditions said to obtain on Mars, but is highly inimical to the preservation of an equable temperature from day to day, since there is nothing to prevent the sun's heat being radiated at once, upon that luminary's setting. The rotation of Venus is unknown, or is once in 225 days; and that of Mars is performed in thirty-seven minutes more than the earth's, or 687 times in the Martian year. Here the resemblance to terrestrial conditions is more apparent than real. The resultant speed at the surface at the earth's equator is about 1,000 miles per hour, while on Mars the equatorial surface rate is approximately 537 miles. If Venus presents always the same face to the sun, her axial inclination cannot, of course, have the smallest influence on her climate. The axial inclination of Mars is 24 deg. 50 min., or 1 deg. 20 min. greater than the earth's; hence the seasonal changes would much resemble those on the earth, other conditions being similar. The Martian poles present white caps in winter, whose areas are much diminished in summer. The complete disappearance of the white cap is on record at least once. The surface presents telescopic lines, which the Flagstaff observers have made very numerous and very fine. An objection to the theory that the lines may be areas of irrigation is found in the fact of their immense length in some cases, and their geometrical straightness. Observation indicates that the Martian surface is not a smooth, even plane, yet the feat of conducting water in every direction to great distances by

* Popular Astronomy.

the shortest arc, has not seemed to baffle the Martian engineers. Similarly the imagination must be staggered at the apparent extent of surface covered by irrigation at the seasonal changes. The so-called fruitful areas are depicted as extending from the polar caps across the equator to thirty-five degrees south or north latitude, with the arrival of the northern or southern summer, as the case may be.

Many of the Flagstaff observations are unconfirmed by other research, though not necessarily rejected, as the instruments and atmospheric conditions at the Arizona station are acknowledged to be of the best. It has been pointed out that markings similar to the grosser ones on Mars have also been described at Flagstaff as present on Venus and Mercury, a coincidence that is singular enough to verge on the incredible.

Upon returning to the original inquiry, from the foregoing considerations which of the planets—Mars or Venus—appears to be better adapted to sustaining intelligent life? It can hardly be denied that the conditions on Mars, where life may be granted to exist, must have modified the Martian species quite out of all form or semblance to those with which the human race is familiar. It is likely that only among the lowest forms of life would the botanist or biologist from the earth look for similar species, and the ages would naturally have evolved a ruling race, adapted to great extremes of temperature, excessive drought and rarity of air, with form and characteristics that altogether baffle speculation. To admit so much is to admit the habitability of Mars after that planet's kind.

For Venus we have observational assurance of a world remarkably like the earth, in several features that are commonly considered essential to the existence of the human race. The older observations on Venus, which established her day as somewhat like the terrestrial day in length, must be allowed to have established the possibility, the probability indeed, of highly developed animal life.

But let it be granted that the rotation of Venus has been determined at the rate of once in the Hesperian year. In the gradual slowing down of the planet's rotation through the ages, would not the intelligence of her inhabitants have risen steadily to each occasion's height, and have met finally the last catastrophe when the scorched and barren hemisphere forever faced the sun? Here, in reality also, we cannot begin to speculate on the outward form of the Hesperian. In much diminished numbers and of slight physique, he was driven back, first to the poles for water and coolness, from thence to spread once more over his planet in the twilight zone of perpetual spring, when for him rotation had ceased. On one side of him lies half the world, a veritable furnace, and on one side eternal night binds the hemisphere in an iron frost that no life can endure. Between the two he is reconciled to a life strange enough, indeed, to human conceptions. Dr. Heward thus describes the supposedly habitable belt: "Between the two separate regions of perpetual night and day, there must lie a wide zone of subdued rose-flushed light, where the climatic conditions may be well suited to the existence of a race of intelligent beings."

It may be imagined that economic existence to the inhabitants of Venus would present few problems with an unlimited supply of water stored up on one hand and unlimited heat on the other. It would seem likely that they have long become accustomed to cyclonic disturbances, and have settled in the more favored tracts out of the regular trade of the winds. They are bereft of a satellite no doubt, but did such exist, its station would be one of unstable equilibrium above the desert hemisphere, and at a great distance.

To observers on the earth, Venus at elongation has always been an object of delight and interest, in her unrivaled splendor and apparent proximity. But a little consideration will show that as a spectacle that exhibition cannot compare with the earth-moon system as seen from Venus. When at her inferior conjunction and invisible to the earth, the sun's light strikes the full earth, with its moon, and reflects to the inhabitants of Venus a glorious star, incomparably finer than anything in their whole sky; casting, no doubt, a distinct and appreciable light upon their darkened portion. As compared with the light from Venus at her greatest brilliance, the earth's reflected light when in opposition to Venus must be far more intense, because at such times, the earth is only 26 million miles from Venus and reflects an entire hemisphere, instead of the half-moon phase, such as Venus presents at her brightest. In addition there is the reflection from the moon's surface, so that the system presents contrasting colors to the Hesperians, a splendid golden star attended by a silver satellite of one-fourth the size.

URANIUM AT JOACHIMSTHAL.

THE CHIEF SOURCE OF RADIO-ACTIVE MATERIALS.

Until quite recent years Joachimsthal, from a mining point of view, was known only for its past history as a silver-producing center. It was the birthplace of the thaler in the sixteenth century, and was at one time one of the most important contributors to the total output of silver in Europe. However, after diminishing continually in output, silver mining has within recent years been entirely given up, and at the present time work is restricted to uranium ore or pitch-blende. The number of miners in the town has now fallen to between one and two hundred.

This district has for many years supplied the great bulk of the pitch-blende used in the manufacture of the uranium salts of commerce; but with the discovery of radium the mining received a great fillip, as a demand arose for low-grade ore. It may as well be stated that amounts of silver and other metals continue to be produced, but only as by-products, at the uranium factory, the pitch-blende, though mostly of great purity, being sometimes associated with small quantities of silver, bismuth, cobalt, nickel, arsenic.

The seat of greatest activity is not at the government mine, as one might be led to imagine from some of the newspaper reports, but at the two mines belonging to a private Saxon mining company. Most of the older shafts are now closed, and the ore now being obtained by the Austrian government comes from the Elias shaft, nearly two miles from the town. The shaft, which is a very old one, is inclined, and there is a drainage adit which commences near the railway station. It is the water from this adit that has the highest radio-activity of all the mine waters analyzed on either the Bohemian or Saxon side of the Erzgebirge. Whether there is any particular benefit to be derived from drinking this radium water is a medical question which will not be discussed here; but it may be stated that the local authorities are working hard to make Joachimsthal a watering place, and last year they had a modest list of 200 *kur-gästen*. The rustic open-air pump, from which the patient at present obtains his beverage, is to be replaced by arrangements more on a par with what one finds at Marienbad and Karlsbad. Naturally these proceedings have not escaped notice in the Kingdom of Saxony, and only a few miles away, over the mountain, a close and comprehensive examination of the mine waters for radio-activity has recently been carried out by Prof. Schiffner, of the Freiburg School of Mines, on behalf of the Saxon government. If the public flock to Joachimsthal we shall probably hear of an opposition radium watering place being started in Saxony.

The geological features of the district are masses of granite inclosing mica-schist, and at times limestone and dolomite. There are seventeen lodes extending east and west, and a similar number crossing them more or less at right angles. The two mines belonging to the private Saxon company are known as Gewerkschaft Hilfe Gottes-Zeche, which started operations in 1852, and the Gewerkschaft Sächs Edelleutstollen, which commenced in 1856. A few details of the latter mine will be of interest. The two lodes now being principally mined are the Franciski and the Zeidler, and they are worked by an adit 1,000 meters long, partly driven, as it is said, at least 600 years ago. The lodes are of variable width, ranging from 3½ yards to 1 inch, the pitch-blende occurring as detached lumps imbedded in the mica-schist. Some of these lumps may weigh several pounds, but a large amount of the ore mined does not run above 3 or 4 per cent of uranium oxide, which has the chemical formula U_3O_8.

The dressing plant at the mine, though at first sight of somewhat rough-and-ready construction, appears to give quite satisfactory results, and the management see no advantage in adopting the more modern machinery so common in other mining fields. In the case of the rich ore very little treatment is required, hand-picking being followed by grinding in a ball mill, the product assaying about 60 per cent uranium oxide. The poorer ore goes to a crusher preparatory to being fed to a battery of wooden stamps, from which it is taken on to a series of wooden percussion tables. These tables, which are made on the spot, are actuated by cams on a 3-foot diameter wooden driving-shaft. The ore from the tables assays on an average 55 per cent uranium oxide.

The bulk of the ore from these two mines is sold by arrangement to the factory of the Austrian government, who are now utilizing the old silver smelter near the new railway station as a uranium factory. The railway, it may be said, is a single line, 5 miles long, built a few years ago, to connect the town with the private Buschtiehrad line, which runs from Prague to Eger. Adjacent to the uranium factory is the quite modern radium laboratory, also belonging to the government, and under the management of Dr. Step. This is the spot whence most of the hospitals have drawn their supplies of radium. Practically the only competitive uranium works to those at Joachimsthal are at Brunswick, and it is here that the radium salts are to be extracted from the Cornish pitch-blende, there being at present no factory in England where uranium ores are worked up.

Up to the present, for a considerable number of years, the market prices of uranium salts have been entirely in the hands of the Austrian government, the output in Saxony having dwindled considerably. As America and Spain contribute only a few tons of very low-grade ore, there are only the two producing districts of Joachimsthal and Cornwall to be considered. Statistics available at the moment show that in 1906 Austria produced 16 metric tons of ore, valued at 10,901*l.*, while the Cornish output in 1906 was 11 tons, a value not stated. In 1907 the Cornish figure was 71 tons, valued at 6,500*l.*, and the advance statistics for 1908 show very similar figures. Presumably this was all yielded by the Grampound-road mine, so that when the figures for the present year come to be published we may expect a considerable augmentation from the St. Ives district. It will thus be seen that the position of Austria in the uranium market is being strongly attacked by Cornwall. As a metal there is no present demand for uranium, and the ores are all converted into salts, such as the acetate, nitrate, and sulphate, used in photography, and in the chemical laboratory. As sodium uranate there is a considerable application for uranium in glass and porcelain manufacture. As regards the price, it will not be far from the mark to put the retail cost of the pure salts at 2s. per ounce. The output of these salts appears to be in the neighborhood of 15 tons per annum, and it is a moot point whether the market can absorb much more.

What the prospects are of mining pitch-blende mainly with a view to the production of radium salts will not be discussed here. An important point, however, may be just mentioned, and that is, that radium as used by the medical specialist apparently retains its virtues for an unlimited time, and we may expect, therefore, that after a time, when the requirements of the hospitals have been met, the demand will fall off.—Engineering.

DECREASE IN RAILROAD FATALITIES.

Several railroads of this country have recently issued reports that are particularly gratifying in that among the large number of passengers carried there have been no fatalities. Among the first of these to make such a report was the Pennsylvania R. R. which carried 142,676,779 passengers in 1908 with not a single accident due to inefficient operation, exclusive of accidents at crossings or the result of the passengers' own carelessness in getting on or off a moving train. Other reports followed which are equally favorable showing that the Chicago & Northwestern Ry. carried 25,994,182 passengers in the year ending June 30th, 1909, without a single fatal accident, the Chicago, Rock Island & Pacific Ry. 18,743,022, the Chicago, Burlington & Quincy Ry. 20,000,000, the Atchison, Topeka & Santa Fe Ry. 22,605,697, the Lehigh Valley R. R. 4,877,801, while the Erie R. R. reports 125,000,000 passengers carried in the past five years without a fatality. These figures make a total of 330,000,000 passengers carried in the past year without fatalities, and it is interesting to note that the roads helping to make up this record are many of them Western roads some of which are operated on single track. It is understood, of course, that a number of roads of lesser mileage have made the same enviable record in this respect, for the instances mentioned above are remarkable only from the magnitude of the traffic involved.—Railway and Engineering Review.

ENGINEERING NOTES.

The next big engineering project on the Great Lakes will be the damming of the Niagara River opposite Buffalo and Fort Erie for the purpose of raising the level of Lake Erie. The International Waterways Commission, which has been working on the problem for several years, has nearly completed its report, and, it is said, will recommend that the dam be built by the Canadian and the United States governments.

A chert road built with bituminous binder in Birmingham, Ala., in 1906, has given unexpectedly good service, according to City Engineer M. Nicholson. The street has a heavy gradient and bad wash. A space 50 feet long running entirely across the roadway and strips 200 feet in length along each gutter for a fourth of the width of the roadway were painted with hot tarvia, sanded, and rolled immediately. Recently the pavement was opened at one place and found to be in fine condition; where the chert had been compacted in the center of the road the tarvia had not penetrated very far, although it had effectually prevented washing.

When the De Laval steam turbine was first brought into the market, the units were small and there was no condensing, and the result was a high steam consumption. Subsequent improvements, however, have tended to reduce the steam consumption so materially that this type of steam turbine now claims a place among the most economical motors. In referring to the figures below it should be borne in mind that the steam consumption refers to effective horse-power, while in many cases it is customary to give the steam consumption per indicated horse-power. One 500-horse-power turbine installed at Stockport, Great Britain, shows a steam consumption per effective horse-power of 13½ pounds per hour; another of 330 horse-power installed in St. Petersburg, Russia, shows a consumption of 12½ pounds per hour.—Machinery

Negotiations were recently concluded whereby a European syndicate takes control of the sixteen best gem mines in Ceylon. These mines up to the present have been under the management of natives and have a romantic fame running back through many centuries. Moonstones, catseyes, rubies, and sapphires are among the stones found in the island. The ruby, however, cannot compare with the rich, deep-colored stones found in Burma, but the sapphire, it is stated, is found there in shades of color unknown in other parts of the world. In the olden days the native artificers cut the star sapphires in a peculiar fashion, but the secret of their art has been forgotten. There are, at present, it is reported, no fewer than 3,366 gem mines in the island.

The small power plants which are part of the mechanical equipment of many office buildings and shops are coming in for considerable discussion now, which seems likely to increase during the next year or two, as to their value to the owner in comparison with central station service. There are engineers with experience in the design and operation of these small isolated plants who hold emphatically that they are more economical than the purchase of current from central stations, while the representatives of the latter point in refutation of such statements to the large number of owners of buildings and shops who have thrown out their plants in order to buy current. Whether this action has been due wholly to a desire to effect economy or to the wish of the owner to be relieved from grafting by the engine-room force and its frequent incompetency, is an open question in a good many cases. The fact remains, however, that so much has been said and written on both sides of the subject, and the debate between the advocates of the two methods of obtaining current is becoming so hot, that the man who pays the bills is likely to be pretty confused if he listens to all the arguments that reach him. According to the Engineering Record, the only way to find out whether it will pay to substitute central station current for an isolated plant, the latter being already installed, is to keep an accurate record of the total cost of operating the latter. It often happens that the engine-room force attends to work which will be necessary even if current is purchased from a central station, for the heating of the building must be provided for and the wiring, elevators, and plumbing require some maintenance. The number of men necessary for this work in a given building or shop ought to be estimated pretty liberally, and the division of their time between the actual management of the isolated plant and this other work should be ascertained carefully. The expenses for oil, fuel, water, and other supplies and the depreciation of the plant can be figured if records are accurately kept, and having these figures the owner will then be able to decide whether it is worth while to make a change. Possibly the main lesson to be learned from such records, particularly when they are compared with records from other similar plants, is that a reform in the engine room would be more economical than a change to central station current.

SCIENCE NOTES.

The notices recently issued by the committee of the International Aeronautical Exhibition at Frankfort show that many valuable prizes have been placed at its disposal, including one by the German Emperor; three prizes are also offered for the best cinematograph films of natural flight. A series of scientific lectures will be delivered, dealing, among other things, with the physics of the upper air.

To Restore Darkened Tan Shoes to Their Light Color.—The shoes, previously thoroughly cleansed from dust and dirt, are rubbed off vigorously with a little sponge, wetted with benzine; this process being repeated every time, as soon as the shoes are dry, until the leather is light colored. Then apply some light yellow cream and brush bright with a brush set aside for light shoes.

Sans Rivale (a paste for filling the pores of wood, before varnishing it).—Take a little of the paste with varnish on a cotton rag and apply it to the wood. This fills the pores and a saving in varnish is effected. The varnish is also rendered harder and more durable. The paste is made by melting rubber cuttings and stirring in powdered pumice stone, the consistency being controlled by the addition of alcohol. The ordinary proportion is 230 parts of rubber waste, 160 parts powdered pumice stone and 60 parts of alcohol.

An article in a contemporary describes some fresh determinations of the amount of radium present in sea water, the specimens being taken from the Atlantic at various places, and at once placed in clean new bottles. All possible precautions were taken to eliminate error, and the mean result for the six samples was 9×10^{-16} gramme per gramme of sea water. This is only about one-seventeenth of the value (1.6×10^{-14}) obtained by Joly, but agrees fairly well with the value 6×10^{-16} previously obtained by Mr. A. S. Eve. It is also shown that, when testing for the quantity of radium emanation present in a given solution, about equal accuracy is obtained by collecting the emanation over water or over mercury.

In order to obtain wind records for Berlin an anemometer was in use on the tower of the Joachimsthal Gymnasium from 1884 to 1903. A paper dealing with the investigation gives the monthly means of wind velocity for each year of this period, and also the hourly means for each month for each of the ten-year periods. The records are mainly interesting as showing the influence of the growth of the town on the exposure. The anemometer was fixed 1.7 meter above the parapet of the tower, which is 32 meters above the ground and 15 meters to 20 meters above the general level of the roof. In 1884 the building was in open country; at the end of the period (1903) it was surrounded on all sides by buildings of average height 22 meters to 25 meters. The effective height of the anemometer above ground was thus reduced by this amount. The mean velocities (in meters per second) for successive lusters were as follows: 1884-88, 5.44; 1889-93, 4.80; 1894-98, 4.04; 1889-1903, 3.82.

In a dissertation, accepted by the University of Halle, R. Bernstein describes some experiments of his on the magnetic properties of gases. The experiments were conducted on the lines of Faraday's method. A glass bulb was suspended in a strong magnetic field from the one arm of a torsion balance and balanced by a counterpoise, and the torsion was measured. The bulb was in successive experiments filled with the respective gas vapor, with air, and evacuated; the magnetic susceptibility of air being known in absolute measure, the magnetic susceptibility of the gas in question could be deduced. At the end of his dissertation, Bernstein suggests some improvements in the construction of the bulbs and of the torsion apparatus, of which he did not make use in the determination of his constants, however. But he compensated for the diamagnetism of the glass, which complicates such experiments considerably, by placing, near the bulb a paramagnetic body, paraffin or brass. The gases examined were purified with care. They were: Carbon dioxide, oxygen, hydrogen, chlorine, the explosive mixture of chlorine and hydrogen, hydrochloric acid, and the vapors: ether, aqueous vapor, bromine, carbon disulphide, and chloroform. As a rule, the gas in the bulb was under a pressure of two atmospheres; experiments with rarefied air were also made, and it would result that the magnetism of a substance as vapor and as liquid is the same for equal weights and equal temperatures. As regards oxygen, which is rather strongly paramagnetic (in the same sense as iron), Bernstein agrees with Faraday and Epimoff, whose figures do not differ much from those of Toepler and Henning and of Quincke. As regards carbon dioxide, which is very feebly paramagnetic (possibly diamagnetic), the agreement is less satisfactory, and the same holds for hydrogen, which seems to be very feebly diamagnetic. Most of the other substances which appear to be feebly diamagnetic had not been examined by other observers.

TRADE NOTES AND FORMULÆ.

Decoloration of Lard.—According to the Reye patent there is added to the liquid lard, at about 167 deg. F. (75 deg. C.), powdered calcium chloride (about 25 parts to 3,000 parts of lard), the mixture is thoroughly worked up together and placed in a filter press. The coloring iron salts are hereby taken up by the calcium chloride and remain in the residue.

Shoe sole finish is prepared by melting 1 part of stearine in an iron kettle, removing it from the fire and taking it into another room, or the open air, where 4 to 5 parts benzine are added to it, stirring the while. The soles are coated with the mixture and rubbed smooth with a linen rag. Or, 5 parts of stearine are melted up with 1 part of white beeswax, some of this being scraped onto the sole, when wanted, rubbed in and polished with a rag.

Gloss Starch.—10 parts each of wax and stearine, after the addition of a few drops of volatile aromatic oil, are heated to melting in a pot. To the hot fluid, stirring carefully meanwhile, 2½ parts of 10 deg. ammonia lye is added, whereby at once a thick, soft mass is produced. On further heating it becomes fluid again, whereupon it is diluted with about 200 parts of boiling water, mixed with about 1,000 parts of starch and poured in molds.

Pencils for Marking Leather.—I. 3 parts lampblack, 4 parts soap, 8 parts yellow wax, 4 parts tallow. II. 2 parts lampblack, 4 parts soap, 8 parts yellow wax, 4 parts spermaceti. For different uses, the mixing proportion may sometimes be slightly varied; the right quantity is determined by test. To produce the mass, the wax and the tallow are first melted over a gentle fire, the soap, which must be cut into thin shavings, also added and finally the lampblack admixed and the whole well stirred. The mass is poured, while hot, into flat slabs, and when cold cut with a saw or a hot knife into little sticks.

Black Coloring for Iron Ornamental Articles.—The articles cleansed and freed from grease by pickling are placed in ten per cent solution of bichromate of potash, dried in air and finally held for two minutes over an open, bright glowing but sootless coal fire. The first coloring is usually blackish brown, but if we repeat the process several times we shall obtain a pure black color. Special attention must be given to the removal of grease, otherwise the greasy places will not be reached by the fluid and the coloring will be uneven. The grease should be removed with benzine and the articles should not afterward be touched with the fingers.

Plastite is a substance resembling whalebone, but differing from it in the possession of a lesser degree of elasticity. To save expensive caoutchouc there is incorporated with the latter in addition to the material for making whalebone, a certain quantity of coal-tar pitch, observing, in the composition of the plastite mass, no very closely prescribed limits. Utilizable plastic masses are, for instance, of the following compositions: 100 parts caoutchouc (rubber), 20 to 25 parts sulphur, 40 to 56 parts magnesia, 40 to 50 parts golden sulphur, 50 to 60 parts coal-tar pitch. The pressure of the plastite mass is effected in heated iron molds and the articles are finally kilned.

Resinate colors are combinations of basic and other aniline colors, like fuchsine, methyl violet, brilliant green, safranine, chrysoidine, etc., with resinic acids. In their production take 100 parts of pale rosin, dissolve it in 10 parts of caustic potash, 33 parts of crystallized soda and 1,000 parts of water and add to the solution, cooled to 120 deg. F., a filtered color solution, stirring constantly. After some time, during which we add to the mixture a solution of metallic salts (for instance, chloride of magnesium) and the color combination, resinate color will be precipitated; it is separated from the fluid by straining through linen, then dried. The colors are easily dissolved in benzole, ether, chloroform, volatile oils, in alcohol, benzine, and turpentine-oil varnishes, in melted wax, rosin, oils, etc.

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